

# World Journal of *Gastrointestinal Surgery*

*World J Gastrointest Surg* 2015 September 27; 7(9): 178-222





## Editorial Board

2012-2016

The *World Journal of Gastrointestinal Surgery* Editorial Board consists of 340 members, representing a team of worldwide experts in pediatrics. They are from 37 countries, including Australia (6), Austria (2), Belgium (6), Brazil (9), Bulgaria (2), Canada (8), China (29), Denmark (1), Finland (2), France (9), Germany (21), Greece (7), India (11), Ireland (3), Israel (3), Italy (49), Jamaica (1), Japan (47), Lithuania (1), Malaysia (1), Netherlands (11), Pakistan (1), Poland (1), Portugal (1), Russia (1), Saudi Arabia (1), Serbia (2), Singapore (5), South Korea (8), Spain (5), Sweden (2), Switzerland (3), Thailand (2), Tunisia (1), Turkey (8), United Kingdom (11), and United States (59).

### EDITOR-IN-CHIEF

Timothy M Pawlik, *Baltimore*

### STRATEGY ASSOCIATE EDITOR-IN-CHIEF

Elijah Dixon, *Calgary*  
Antonello Forgione, *Milan*  
Tobias Keck, *Freiburg*  
Tsuyoshi Konishi, *Tokyo*  
Natale Di Martino, *Naples*

### GUEST EDITORIAL BOARD MEMBERS

Chao-Long Chen, *Kaohsiung*  
Chien-Hung Chen, *Taipei*  
Hsin-Yuan Fang, *Taichung*  
Jong-Shiaw Jin, *Taipei*  
Chen-Guo Ker, *Kaohsiung*  
King-Teh Lee, *Kaohsiung*  
Wei-Jei Lee, *Taoyuan*  
Shiu-Ru Lin, *Kaohsiung*  
Wan-Yu Lin, *Taichung*  
Yan-Shen Shan, *Tainan*  
Yau-Lin Tseng, *Tainan*  
Jaw-Yuan Wang, *Kaohsiung*  
Li-Wha Wu, *Tainan*

### MEMBERS OF THE EDITORIAL BOARD



#### Australia

Ned Abraham, *Coffs Harbour*  
Robert Gibson, *Victoria*  
Michael Michael, *Victoria*  
David Lawson Morris, *Kogarah*  
Jaswinder Singh Samra, *Leonards*  
M Wilhelm Wichmann, *Mount Gambier*



#### Austria

Harald R Rosen, *Vienna*  
Franz Sellner, *Vienna*



#### Belgium

Giovanni Dapri, *Brussels*  
Jean-François Gigot, *Brussels*  
Lerut Jan Paul Marthe, *Brussels*  
Gregory Peter Sergeant, *Leuven*  
Hans Van Vlierberghe, *Gent*  
Jean-Louis Vincent, *Brussels*



#### Brazil

Jose E Aguilar-Nascimento, *Cuiaba*  
Mario Reis Alvares-da-Silva, *Porto Alegre*  
Fernando Martín Biscione, *Minas Gerais*  
Julio Coelho, *Curitiba*  
José Sebastião dos Santos, *Ribeirão Preto*  
Marcel Autran Machado, *São Paulo*  
Marcelo AF Ribeiro, *Santana de Parnaíba*  
Marcus V Motta Valadão, *Rio de Janeiro*  
Ricardo Zorron, *Rio de Janeiro*



#### Bulgaria

Krassimir Dimitrow Ivanov, *Varna*  
Belev Vasilev Nikolai, *Plovdiv Plovdiv*



#### Canada

Runjan Chetty, *Ontario*  
Laura Ann Dawson, *Ontario*

Mahmoud A Khalifa, *Toronto*  
Peter C Kim, *Ontario*  
Peter Metrakos, *Quebec*  
Reda S Saad, *Toronto*  
Manuela Santos, *Montreal*



#### China

Yue-Zu Fan, *Shanghai*  
Wen-Tao Fang, *Shanghai*  
Yong-Song Guan, *Chengdu*  
Shao-Liang Han, *Wenzhou*  
Michael Garnet Irwin, *Hong Kong*  
Long Jiang, *Shanghai*  
Wai Lun Law, *Hong Kong*  
Ting-Bo Liang, *Hangzhou*  
Quan-Da Liu, *Beijing*  
Yu-Bin Liu, *Guangdong*  
Jian-Yang Ma, *Chengdu*  
Kwan Man, *Hong Kong*  
Tang Chung Ngai, *Hong Kong*  
Yan-Ning Qian, *Nanjing*  
Ai-Wen Wu, *Beijing*  
Yun-Fei Yuan, *Guangzhou*



#### Denmark

Thue Bisgaard, *Koge*



#### Finland

Helena Mariitta Isoniemi, *Helsinki*  
Isto Henrik Nordback, *Tampere*



#### France

Mustapha Adham, *Lyon Cedex*

Chapel Alain, *Paris*  
 Brice Gayet, *Paris*  
 Jean-François Gillion, *Antony*  
 Guilhem Godlewski, *Saint Chaptes*  
 D Heresbach, *Rennes Cedex*  
 Romaric Loffroy, *Dijon Cedex*  
 Jacques Marescaux, *Strasbourg Cedex*  
 Aurelie Plessier, *Clichy*



#### Germany

Hans G Beger, *Ulm*  
 Vollmar Brigitte, *Rostock*  
 Dieter C Broering, *Kiel*  
 Ansgar Michael Chromik, *Regensburg*  
 Marc-H Dahlke, *Regensburg*  
 Irene Esposito, *Neuherberg*  
 Stefan Fichtner-Feigl, *Regensburg*  
 Benedikt Josef Folz, *Bad Lippspringe*  
 Helmut Friess, *Munich*  
 Reinhart T Grundmann, *Burghausen*  
 Bertram Illert, *Würzburg*  
 Jakob Robert Izbicki, *Hamburg*  
 Jörg H Kleeff, *Munich*  
 Axel Kleespies, *Munich*  
 Uwe Klinge, *Aachen*  
 Martin G Mack, *Frankfurt*  
 Klaus Erik Mönkemüller, *Bottrop*  
 Matthias Peiper, *Dusseldorf*  
 Hubert Scheidbach, *Magdeburg*  
 Joerg Theisen, *Munich*



#### Greece

Teni Bouliskas, *Athens*  
 Eelco de Bree, *Herakleion*  
 Stavros J Gourgiotis, *Athens*  
 Andreas Manouras, *Athens*  
 Theodoros E Pavlidis, *Thessaloniki*  
 George H Sakorafas, *Athens*  
 Vassilios E Smyrniotis, *Athens*



#### India

Anil Kumar Agarwal, *New Delhi*  
 Samik Kumar Bandyopadhyay, *Kolkata*  
 Shams ul Bari, *Kashmir*  
 Somprakash Basu, *Varanasi*  
 Pravin Jaiprakash Gupta, *Nagpur*  
 Vinay Kumar Kapoor, *Lucknow*  
 Chandra Kant Pandey, *Lucknow*  
 Shailesh V Shrikhande, *Mumbai*  
 Sadiq Saleem Sikora, *Bangalore*  
 Rakesh K Tandon, *New Delhi*  
 Imtiaz Ahmed Wani, *Srinagar*



#### Ireland

Kevin CP Conlon, *Dublin*  
 Prem Puri, *Dublin*  
 Eamonn Martin Quigley, *Cork*



#### Israel

Ariel Halevy, *Zerifin*

Jesse Lachter, *Haifa*  
 Hagit Tulchinsky, *Tel Aviv*



#### Italy

Angelo Andriulli, *San Giovanni Rotondo*  
 Giuseppe Aprile, *Udine*  
 Gianni Biancofiore, *Pisa*  
 Stefania Boccia, *Rome*  
 Luigi Bonavina, *Piazza Malan*  
 Pier Andrea Borea, *Ferrara*  
 Giovanni Cesana, *Milano*  
 Stefano Crippa, *Verona*  
 Giovanni D De Palma, *Napoli*  
 Giovanni de Simone, *Napoli*  
 Giorgio Di Matteo, *Rome*  
 Giorgio Ercolani, *Bologna*  
 Carlo V Feo, *Ferrara*  
 Simone Ferrero, *Genova*  
 Valenza Franco, *Milano*  
 Leandro Gennari, *Rozzano*  
 Felice Giuliente, *Rome*  
 Calogero Iacono, *Verona*  
 Riccardo Lencioni, *Pisa*  
 Dottor Fabrizio Luca, *Milano*  
 Giuseppe Malleo, *Verona*  
 Paolo Massucco, *Candiolo*  
 Giulio Melloni, *Milan*  
 Paolo Morgagni, *Forli*  
 Chiara Mussi, *Rozzano*  
 Gabriella Nesi, *Florence*  
 Angelo Nespoli, *Monza*  
 Giuseppe R Nigri, *Rome*  
 Fabio Pacelli, *Rome*  
 Corrado Pedrazzani, *Siena*  
 Roberto Persiani, *Rome*  
 Pasquale Petronella, *Napoli*  
 Piero Portincasa, *Bari*  
 Stefano Rausei, *Varese*  
 Carla Ida Ripamonti, *Milano*  
 Antonio Russo, *Palermo*  
 Giulio A Santoro, *Treviso*  
 Stefano Scabini, *Genoa*  
 Giuseppe S Sica, *Rome*  
 Gianfranco Silecchia, *Rome*  
 Mario Testini, *Bari*  
 Guido Alberto Massimo Tiberio, *Brescia*  
 Umberto Veronesi, *Milano*  
 Bruno Vincenzi, *Rome*  
 Marco Vivarelli, *Bologna*  
 Alberto Zaniboni, *Brescia*  
 Alessandro Zerbi, *Milano*



#### Jamaica

Joseph Martin Plummer, *Kingston*



#### Japan

Yasunori Akutsu, *Chiba*  
 Ryuichiro Doi, *Kyoto*  
 Yosuke Fukunaga, *Sakai*  
 Akira Furukawa, *Shiga*  
 Shigeru Goto, *Oita*  
 Kazuhiko Hayashi, *Tokyo*  
 Naoki Hiki, *Tokyo*

Takeyama Hiromitsu, *Nagoya*  
 Tsujimoto Hironori, *Tokorozawa*  
 Tsukasa Hotta, *Wakayama*  
 Yutaka Iida, *Gifu City*  
 Kazuaki Inoue, *Yokohama*  
 Masashi Ishikawa, *Masa*  
 Tatsuo Kanda, *Niigata*  
 Tatsuyuki Kawano, *Tokyo*  
 Keiji Koda, *Chiba*  
 Hajime Kubo, *Kyoto*  
 Iruru Maetani, *Tokyo*  
 Yoshimasa Maniwa, *Kobe*  
 Toru Mizuguchi, *Hokkaido*  
 Zenichi Morise, *Toyoake*  
 Yoshihiro Moriwaki, *Yokohama*  
 Yoshihiro Moriya, *Tokyo*  
 Satoru Motoyama, *Akita*  
 Hiroaki Nagano, *Osaka*  
 Masato Nagino, *Nagoya*  
 Kazuyuki Nakamura, *Yamaguchi*  
 Shingo Noura, *Osaka*  
 Kazuo Ohashi, *Tokyo*  
 Yoichi Sakurai, *Aichi*  
 Hirozumi Sawai, *Nagoya*  
 Shouji Shimoyama, *Tokyo*  
 Masayuki Sho, *Nara*  
 Yasuhiko Sugawara, *Tokyo*  
 Hiroshi Takamori, *Kumamoto*  
 Sonshin Takao, *Kagoshima*  
 Kuniya Tanaka, *Yokohama*  
 Masanori Tokunaga, *Sunto-gun*  
 Yasunobu Tsujinaka, *Chiba*  
 Akira Tsunoda, *Chiba*  
 Toshifumi Wakai, *Niigata City*  
 Jiro Watari, *Hyogo*  
 Shinichi Yachida, *Kagawa*  
 Yasushi Yamauchi, *Fukuoka*  
 Hiroki Yamaue, *Wakayama*  
 Yutaka Yonemura, *Oosaka*



#### Lithuania

Donatas Venskutonis, *Kaunas*



#### Malaysia

Way Seah Lee, *Kuala Lumpur*



#### Netherlands

Lee H Bouwman, *The Hague*  
 Wim A Buuman, *Maastricht*  
 Robert Chamuleau, *Amsterdam*  
 Miguel A Cuesta, *Amsterdam*  
 Jeroen Heemskerk, *Roermond*  
 Buis Carlijn Ineke, *Deventer*  
 Wjhj Meijerink, *Amsterdam*  
 Poortman Pieter, *Amsterdam*  
 Jan Stoot, *Sittard*  
 Chj van Eijck, *Rotterdam*  
 Alexander Lucas Vahrmeijer, *Leiden*



#### Pakistan

Kamran Khalid, *Lahore*

**Poland**

Bogusław B Machalinski, *Szczecin*

**Portugal**

Jorge Correia-Pinto, *Braga*

**Russia**

Grigory G Karmazanovsky, *Moscow*

**Saudi Arabia**

Salman Y Guraya, *Madina Al Munawara*

**Serbia**

Ivan Jovanovic, *Belgrade*

Miroslav Nikola Milicevic, *Beograd*

**Singapore**

Brian KP Goh, *Singapore*

John M Luk, *Singapore*

Francis Seow-Choen, *Singapore*

Vishalkumar G Shelat, *Tan Tock Seng*

Melissa Teo, *Singapore*

**South Korea**

Joon Koo Han, *Seoul*

Hyung-Ho Kim, *Seongnam*

Woo Ho Kim, *Seoul*

Sang Yeoup Lee, *Gyeongangnam-do*

Woo Yong Lee, *Seoul*

Hyo K Lim, *Seoul*

Jae Hyung Noh, *Seoul*

Sung Hoon Noh, *Seoul*

**Spain**

Antonio M Lacy Fortuny, *Barcelona*

Laura Lladó Garriga, *Barcelona*

Prieto Jesus, *Pamplona*

David Pares, *Sant Boi de Llobregat*

Francisco José Vizoso, *Gijón*

**Sweden**

Helgi Birgisson, *Uppsala*

Jörgen Rutegard, *Umea*

**Switzerland**

Pascal Gervaz, *Geneva*

Bucher Pascal, *Geneva*

Marc Pusztaszeri, *Carouge*

**Thailand**

Varut Lohsiriwat, *Bangkok*

Rungsun Rerknimitr, *Bangkok*

**Tunisia**

Nafaa Arfa, *Sidi Daoued-Tunis*

**Turkey**

A Ziya Anadol, *Besevler*

Unal Aydin, *Gaziantep*

Mehmet Fatih Can, *Etlik*

Gozde Kir, *Umraniye-Istanbul*

Adnan Narci, *Afyonkarahisar*

Ilgin Ozden, *Istanbul*

Mesut Abdulkerim Unsal, *Trabzon*

Omer Yoldas, *Ordu*

**United Kingdom**

Graeme Alexander, *Cambridge*

Simon R Bramhall, *Birmingham*

Brian Ritchie Davidson, *London*

Andrea Frilling, *London*

Giuseppe Fusai, *London*

Gianpiero Gravante, *Leicester*

Najib Haboubi, *Manchester*

Mohammad Abu Hilal, *Southampton*

Aftab Alam Khan, *Kent*

Aravind Suppiah, *Scarborough*

Caroline S Verbeke, *Leeds*

**United States**

Eddie K Abdalla, *Houston*

Forse Robert Armour, *Omaha*

Marc D Basson, *Lansing*

James M Becker, *Boston*

Thomas David Boyer, *Tucson*

Michael E de Vera, *Pittsburgh*

Andrew J Duffy, *New Haven*

Kelli Bullard Dunn, *New York*

Thomas Fabian, *New Haven*

P Marco Fisichella, *Maywood*

Raja M Flores, *New York*

Markus Frank, *Boston*

Niraj J Gusani, *Hershey*

Paul D Hansen, *Portland*

Douglas W Hanto, *Boston*

John P Hoffman, *Philadelphia*

Scott A Hundahl, *Sacramento*

Michel Kahaleh, *Charlottesville*

David S Kauvar, *San Antonio*

Mary Margaret Kemeny, *Jamaica*

Vijay P Khatri, *Sacramento*

Joseph Kim, *Duarte*

Andrew Scott Klein, *Los Angeles*

Richard A Kozarek, *Seattle*

Robert A Kozol, *Farmington*

Sunil Krishnan, *Houston*

Atul Kumar, *Northport*

Wei Li, *Seattle*

Keith Douglas Lillemoe, *Indianapolis*

Henry T Lynch, *Omaha*

Paul Ellis Marik, *Philadelphia*

Robert Clell Miller, *Rochester*

Thomas J Miner, *Providence*

Ravi Murthy, *Houston*

Atsunori Nakao, *Pittsburgh*

Hirofumi Noguchi, *Dallas*

Jeffrey A Norton, *Stanford*

Nicholas J Petrelli, *Newark*

Alessio Pigazzi, *Duarte*

James John Pomposelli, *Carlisle*

Mitchell C Posner, *Chicago*

Alexander S Rosemurgy, *Tampa*

Sukamal Saha, *Flint*

Reza F Saidi, *Boston*

Aaron R Sasson, *Omaha*

Christian Max Schmidt, *Indianapolis*

Perry Shen, *Winston-Salem*

Ali Ahmed Siddiqui, *Texas*

Frank A Sinicrope, *Rochester*

John H Stewart, *Winston-Salem*

Paul H Sugarbaker, *Washington*

Douglas S Tyler, *Durham*

Vic Velanovich, *Detroit*

Alan Wilkinson, *Los Angeles*

M Michael Wolfe, *Boston*

Christopher L Wolfgang, *Baltimore*

You-Min Wu, *Little Rock*

Zhi Zhong, *Charleston*

**EDITORIAL**

- 178 Detection methods and clinical significance of free peritoneal tumor cells found during colorectal cancer surgery

*Sibio S, Fiorani C, Stolfi C, Divizia A, Pezzuto R, Montagnese F, Bagaglini G, Sammartino P, Sica GS*

**MINIREVIEWS**

- 185 Need for simulation in laparoscopic colorectal surgery training  
*Celentano V*
- 190 Management of afferent loop obstruction: Reoperation or endoscopic and percutaneous interventions?  
*Blouhos K, Boulas KA, Tsalis K, Hatzigeorgiadis A*

**ORIGINAL ARTICLE****Basic Study**

- 196 Response to chemoradiotherapy and lymph node involvement in locally advanced rectal cancer  
*García-Flórez LJ, Gómez-álvarez G, Frunza AM, Barneo-Serra L, Fresno-Forcelledo MF*

**Case Control Study**

- 203 Validation of a new scoring system: Rapid assessment faecal incontinence score  
*de la Portilla F, Calero-Lillo A, Jiménez-Rodríguez RM, Reyes ML, Segovia-González M, Maestre MV, García-Cabrera AM*

**Retrospective Study**

- 208 Impact of surgical delay on outcomes in elderly patients undergoing emergency surgery: A single center experience  
*Ong M, Guang TY, Yang TK*

**Prospective Study**

- 214 Laying open (deroofing) and curettage under local anesthesia for pilonidal disease: An outpatient procedure  
*Garg P, Garg M, Gupta V, Mehta SK, Lakhtaria P*

**CASE REPORT**

- 219 Acute pancreatitis complicated with splenic rupture: A case report  
*Hernani BL, Silva PC, Nishio RT, Mateus HC, Assef JC, De Campos T*



## Contents

*World Journal of Gastrointestinal Surgery*  
Volume 7 Number 9 September 27, 2015

### ABOUT COVER

Editorial Board Member of *World Journal of Gastrointestinal Surgery*, Melissa Teo, MBBS, FRCS, FAMS, Department of Surgical Oncology, National Cancer Centre of Singapore 11 Hospital, Singapore 169610, Singapore

### AIM AND SCOPE

*World Journal of Gastrointestinal Surgery* (*World J Gastrointest Surg*, *WJGS*, online ISSN 1948-9366, DOI: 10.4240) is a peer-reviewed open access academic journal that aims to guide clinical practice and improve diagnostic and therapeutic skills of clinicians.

*WJGS* covers topics concerning micro-invasive surgery; laparoscopy; hepatic, biliary, pancreatic and splenic surgery; surgical nutrition; portal hypertension, as well as associated subjects. The current columns of *WJGS* include editorial, frontier, diagnostic advances, therapeutics advances, field of vision, mini-reviews, review, topic highlight, medical ethics, original articles, case report, clinical case conference (Clinicopathological conference), and autobiography. Priority publication will be given to articles concerning diagnosis and treatment of gastrointestinal surgery diseases. The following aspects are covered: Clinical diagnosis, laboratory diagnosis, differential diagnosis, imaging tests, pathological diagnosis, molecular biological diagnosis, immunological diagnosis, genetic diagnosis, functional diagnostics, and physical diagnosis; and comprehensive therapy, drug therapy, surgical therapy, interventional treatment, minimally invasive therapy, and robot-assisted therapy.

We encourage authors to submit their manuscripts to *WJGS*. We will give priority to manuscripts that are supported by major national and international foundations and those that are of great basic and clinical significance.

### INDEXING/ ABSTRACTING

*World Journal of Gastrointestinal Surgery* is now indexed in PubMed Central, PubMed, Digital Object Identifier, and Directory of Open Access Journals.

### FLYLEAF

#### I-III Editorial Board

### EDITORS FOR THIS ISSUE

Responsible Assistant Editor: *Xiang Li*  
Responsible Electronic Editor: *Dan Li*  
Proofing Editor-in-Chief: *Lian-Sheng Ma*

Responsible Science Editor: *Fang-Fang Ji*  
Proofing Editorial Office Director: *Xiu-Xia Song*

NAME OF JOURNAL  
*World Journal of Gastrointestinal Surgery*

ISSN  
ISSN 1948-9366 (online)

LAUNCH DATE  
November 30, 2009

FREQUENCY  
Monthly

EDITOR-IN-CHIEF  
**Timothy M Pawlik, MD, MPH, FACS, Associate Professor** of Surgery and Oncology, Hepatobiliary Surgery Program Director, Director, Johns Hopkins Medicine Liver Tumor Center Multi-Disciplinary Clinic, Co-Director of Center for Surgical Trials and Outcomes Research, Johns Hopkins Hospital, 600 N. Wolfe Street, Harvey 611, Baltimore, MD 21287, United States

EDITORIAL OFFICE  
Jin-Lei Wang, Director

Xiu-Xia Song, Vice Director  
*World Journal of Gastrointestinal Surgery*  
Room 903, Building D, Ocean International Center,  
No. 62 Dongsihuan Zhonglu, Chaoyang District,  
Beijing 100025, China  
Telephone: +86-10-85381891  
Fax: +86-10-85381893  
E-mail: [editorialoffice@wjnet.com](mailto:editorialoffice@wjnet.com)  
Help Desk: <http://www.wjnet.com/esps/helpdesk.aspx>  
<http://www.wjnet.com>

PUBLISHER  
Baishideng Publishing Group Inc  
8226 Regency Drive,  
Pleasanton, CA 94588, USA  
Telephone: +1-925-223-8242  
Fax: +1-925-223-8243  
E-mail: [bpoffice@wjnet.com](mailto:bpoffice@wjnet.com)  
Help Desk: <http://www.wjnet.com/esps/helpdesk.aspx>  
<http://www.wjnet.com>

PUBLICATION DATE  
September 27, 2015

#### COPYRIGHT

© 2015 Baishideng Publishing Group Inc. Articles published by this Open-Access journal are distributed under the terms of the Creative Commons Attribution Non-commercial License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non commercial and is otherwise in compliance with the license.

#### SPECIAL STATEMENT

All articles published in journals owned by the Baishideng Publishing Group (BPG) represent the views and opinions of their authors, and not the views, opinions or policies of the BPG, except where otherwise explicitly indicated.

#### INSTRUCTIONS TO AUTHORS

Full instructions are available online at [http://www.wjnet.com/1948-9366/g\\_info\\_20100305152206.htm](http://www.wjnet.com/1948-9366/g_info_20100305152206.htm)

ONLINE SUBMISSION  
<http://www.wjnet.com/esps/>

## Detection methods and clinical significance of free peritoneal tumor cells found during colorectal cancer surgery

Simone Sibio, Cristina Fiorani, Carmine Stolfi, Andrea Divizia, Roberto Pezzuto, Fabrizio Montagnese, Giulia Bagaglini, Paolo Sammartino, Giuseppe Sigismondo Sica

Simone Sibio, Paolo Sammartino, Department of Surgery  
Pietro Valdani, Sapienza University of Rome, 00155 Rome, Italy

Cristina Fiorani, Carmine Stolfi, Andrea Divizia, Roberto Pezzuto, Fabrizio Montagnese, Giulia Bagaglini, Giuseppe Sigismondo Sica, Department of Surgical Science, Tor Vergata University of Rome, 00133 Rome, Italy

**Author contributions:** Sibio S and Sica GS wrote the paper; Fiorani C, Stolfi C, Divizia A, Pezzuto R, Bagaglini G and Sammartino P performed the literature review; Montagnese F and Sica GS critically reviewed the paper.

**Conflict-of-interest statement:** All the authors of this manuscript have no conflict of interest.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Correspondence to:** Giuseppe Sigismondo Sica, MD, PhD, Department of Surgical Science, Tor Vergata University of Rome, viale Oxford 81, 00133 Rome, Italy. [sisica@gmail.com](mailto:sisica@gmail.com)  
Telephone: +39-06-20902927  
Fax: +39-06-20902925

Received: March 19, 2015  
Peer-review started: March 21, 2015  
First decision: April 10, 2015  
Revised: June 10, 2015  
Accepted: July 11, 2015  
Article in press: July 14, 2015  
Published online: September 27, 2015

### Abstract

Peritoneal washing is now part of the standard clinical practice in several abdominal and pelvic neoplasias. However, in colorectal cancer surgery, intra-peritoneal free cancer cells (IFCC) presence is not routinely investigated and their prognostic meaning is still unclear. When peritoneal washing results are positive for the presence of IFCC a worse outcome is usually expected in these colorectal cancer operated patients, but it what is not clear is whether it is associated with an increased risk of local recurrence. It is authors' belief that one of the main reasons why IFCC are not researched as integral part of the routine staging system for colon cancer is that there still isn't a diagnostic or detection method with enough sensibility and specificity. However, the potential clinical implications of a routine research for the presence IFCC in colon neoplasias are enormous: not only to obtain a more accurate clinical staging but also to offer different therapy protocols, based on the presence of IFCC. Based on this, adjuvant chemotherapy could be offered to those patients found to be positive for IFCC; also, protocols of proactive intraperitoneal chemotherapy could be applied. Although presence of IFCC appears to have a valid prognostic significance, further studies are needed to standardize detection and examination procedures, to determine if there are and which are the stages more likely to benefit from routine search for IFCC.

**Key words:** Colorectal cancer; Cytology; Free cancer cells; Peritoneal recurrence; Proactive treatment

© The Author(s) 2015. Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** This invited editorial looks for the role of

intra-peritoneal free cancer cells (IFCC) in the surgical practice for colorectal cancer. Prognostic significance of IFCC in colorectal cancer patients is still not clear. Several studies have been published but detection systems are still highly heterogeneous and results remain misleading. Peritoneal cytology could be useful in early-stage cancers to identify subsets of patients with potential worse prognosis, who may be good candidates for adjuvant treatment or even prophylactic intraperitoneal chemotherapy. Current available data need stronger validation to include IFCC in the routine staging protocols of colorectal cancer patients. However, it is the authors' belief that cancer cells found free in the peritoneum of patients with colon cancer, must have a biological and a clinical role. The means of detection based on real time polymerase chain reaction, will surely add power to conventional cytology and with the improvement in sensibility of the methods the clinical role of IFCC could eventually become clear. New therapy protocols might be applied.

Sibio S, Fiorani C, Stolfi C, Divizia A, Pezzuto R, Montagnese F, Bagagli G, Sammartino P, Sica GS. Detection methods and clinical significance of free peritoneal tumor cells found during colorectal cancer surgery. *World J Gastrointest Surg* 2015; 7(9): 178-184 Available from: URL: <http://www.wjgnet.com/1948-9366/full/v7/i9/178.htm> DOI: <http://dx.doi.org/10.4240/wjgs.v7.i9.178>

## INTRODUCTION

Worldwide, colorectal cancer is the third most prevalent malignancy accounting for over 1 million new cases per year with more than 500000 deaths<sup>[1]</sup>. Incidence in Europe exceeds 400000 per year<sup>[2]</sup>.

More than 25%-35% of patients with either early or advanced colorectal cancer will develop peritoneal recurrence alone after a first line treatment; peritoneal carcinomatosis is present in up to 44% of patients with recurrent colorectal cancer; the presence of synchronous or metachronous peritoneal metastasis is associated with poor prognosis<sup>[3,4]</sup> accounting for more than one third of all deaths.

Despite recent advances in gaining a thorough knowledge of clinical, biological and pathological behavior of colorectal cancer, the most commonly used staging systems for colorectal cancer are the Tumor-Node-Metastasis (TNM) and the modified Duke's staging systems<sup>[5-7]</sup>. Expected prognosis, treatment choice and adjuvant chemotherapy are based on results provided by these staging systems which consider the local extension of the disease, the lymph nodes involvement and the eventual presence of distant metastases<sup>[8]</sup>.

Both these staging systems are highly heterogeneous within each stage, sometimes resulting in very different prognosis for patients that share the same stage. This is particularly true in patients in stage II and III<sup>[9-11]</sup> and it may explain why also patients with early stage cancers

could develop local or distant recurrence. Furthermore, according to this staging procedure, early stage patients are not appropriate candidates for adjuvant chemotherapy even though the probability of peritoneal recurrence in these patients seems to be equal to those with more advanced cancers.

Recent studies identified only a limited subset of patients suitable for the extensive surgical treatment and the intraperitoneal heated chemotherapy (HIPEC) with promising results in terms of both recovery from disease and overall survival<sup>[12-16]</sup>. Nevertheless, ten years survival in this limited cohort of patients appears to be a disappointing accomplishment in most qualified studies, in 10% of patients<sup>[17]</sup>. More recently extensive surgery and HIPEC has been proposed to prevent peritoneal recurrence in selected cases found to have advanced mucinous cancers with positive peritoneal lavage: although the first results seem promising, such an approach is still merely investigational<sup>[18-20]</sup>.

Peritoneal cytology from peritoneal lavage is routinely performed in staging esophageal - gastric and pancreatic malignancies and it has a definitive prognostic role in ovarian cancer<sup>[21-26]</sup>. Free intra-peritoneal cancer cells (IFCC) dissemination can occur either spontaneously or because of surgical manipulation, and follows a complex mechanism of circulation, adhesion and invasion of peritoneal surfaces.

## MECHANISM OF PERITONEAL SHEDDING, CIRCULATION AND SEEDING OF CANCER CELLS

IFCC are found in peritoneal washing of as much as 25% of colorectal cancer patients<sup>[27]</sup>. Mechanisms of seeding and the cascade of events, which may lead to their adhesion to peritoneal surface and subsequent peritoneal metastasis development, consist in several well-defined steps. Detachment of cells from primary tumor is the first and it can occur spontaneously. Down regulation of cell adhesion molecules CAMs, such as E-cadherin, associated with high interstitial pressure due to the lack of a well organized lymphatic drainage inside the tumor explains this mechanism, which is effective just when the tumor involves the colon serosal surface (T3) or when spontaneous bowel perforation occurs<sup>[28,29]</sup>.

Surgery itself represents a highly effective mechanism to (that favors) peritoneal cancer spread. Theoretically, even when tumor's manipulation is limited, tumor spill is possible from blood or lymphatic vessels section<sup>[30]</sup>. This cells show proliferation and invasive potentials and are capable of developing metastasis. Once detached, cells follow well known peritoneal routes which are the same of peritoneal fluid drainage and reabsorption, driven by gravity force, diaphragmatic excursion and mesenteric reflections, towards and from the pelvis, along the right para-colic gutter and the sub-diaphragmatic space. Moreover, tumor cells showed inherent motility<sup>[31]</sup>. An-



other possible iatrogenic mechanism of free cancer cells spilling and diffusion could be associated with the laparoscopic technique<sup>[32]</sup>. However, large clinical trials found no differences in peritoneal recurrence risk between open and laparoscopic surgery for colorectal cancer, possibly because the carbon dioxide potential effect is minimized by the reduced peritoneal trauma of the laparoscopic access<sup>[33]</sup>. A preferred location for free tumor cells seeding is represented by the omentum because of its discontinuous mesothelial lining and the presence of milky spots.

Surgery contributes to tumor cells spilling and adhesion even by other post surgical physiological effects: Post-operative tissue inflammation and wound healing is mediated by macrophages which produce an array of mediators able to enhance tumor growth, while pro-inflammatory cytokines enhance mesothelial adhesion molecules expression. Even fibrin can entrap tumor cells during the wound healing process. After mesothelial adhesion, tumor cells become able to pass through the peritoneal discontinuity areas or even to promote mesothelial cells apoptosis as well<sup>[34]</sup>. Matrix metalloproteinases inhibition seems also to be associated with extracellular matrix degradation, thus allowing tumor cells invasion of layers.

## IFCC DETECTION METHODS

Several studies tried to detect IFCC immediately before and after curative surgery for colorectal cancer<sup>[35-37]</sup>, using different methods and arrays with different sensitivity. A recent large review on this issue by Mohan *et al.*<sup>[38]</sup> revised 18 studies out of 3805 found, on 3197 colorectal cancer patients; large heterogeneity was found in peritoneal washing methods in terms of volume and solutions, timing of washing, and laboratory techniques. Most used techniques include conventional cytology, immunological or radio-immunoassays methods, molecular techniques as real time or endpoint polymerase chain reaction (PCR). Heterogeneity of peritoneal washing techniques, timing and samples analysis accounts for the main issue in clarifying the impact of intraperitoneal free cancer cells on prognosis and risk to develop peritoneal recurrence in colorectal cancer patients<sup>[39]</sup>.

Disseminated intraperitoneal cancer cells in colorectal cancer patients may be detected using a range of techniques including examination of peritoneal fluid using conventional cytology, cytology following immune-marker staining, PCR or immunocytochemistry.

The timing of the detection may vary and can occur either pre or post-tumor resection<sup>[40]</sup>.

## CONVENTIONAL CYTOLOGY AND CYTOLOGY FOLLOWING IMMUNE-MARKERS STAINING

Peritoneal cytology can be performed without lavage when free peritoneal fluid is present. In the absence

of peritoneal fluid, a lavage with saline serum (NaCl 0.9%) is needed. The volume of fluid used is extremely variable, ranging from 50 to 1000 mL, but most authors use a small amount of liquid (100-200 mL) delivered around the tumor, where most cells are usually found. Wet fixed direct smears are prepared from the aspirated material after centrifugation and discarding the supernatant. Two or three slides are fixed immediately to prevent cell degeneration. Papanicolaou is a highly suitable staining method also to sediment preparations from fluids. It offers a great advantage with regard to comparative cell studies in histological sections. However Hematoxylin-Eosin, May-Grünwald-Giemsa, Diff-Quik, and other staining methods are also used.

Cyto-centrifuge preparation is recommended for small amounts of fluid with sparse cellular content. Thin layer preparation (cytospin, ThinPrep, and others) is becoming more and more popular. The method may be preferred for adjacent analyses. The remaining cellular material should be retained and stored at 4 °C, mixed up with a certain amount of the supernatant.

Adenocarcinoma of the large bowel may be suggested by those cases that display small and large compact irregular papillary clusters. The epithelial glandular cells are large and cylindrical, and show a palisade arrangement.

Immuno-stains for CK7 and CK20 expression yield a negative and a positive staining result, respectively<sup>[41,42]</sup>.

## IMMUNO-CYTOCHEMISTRY

Immuno-cytochemical methods are based on the staining of tumor cells using specific antibodies against tissue (tumor) specific antigens. Target antigens include EpCAM members of the cytokeratin family or other antigens, which are overexpressed on tumor cells (HER2-neu or MUC-1) but not on other normal cells. These antibodies are either directly labeled with horseradish peroxidase, alkaline phosphatase or fluorescent proteins, or otherwise the antigen-antibody complex is visualized by a labeled second antibody, as in the alkaline phosphatase anti-alkaline phosphatase method. To discriminate between malignant cells and non-specifically stained non-malignant cells, an additional evaluation step that includes morphological criteria and/or an additional counterstaining is necessary. This step employs a second tumor cell-specific antigen or an antibody against a CD marker as CD45. During the last years several computeraided search systems have been developed which are used for scanning of microscope slide analysis. Enriched fractions are commonly centrifuged onto microscope slides (cytospins) for immune-cytochemical detections.

## PCR-BASED METHODS

PCR-based methods are widely used for the detection of IFCC, targeting both DNA and RNA markers. DNA is generally stable and independent of the transcription

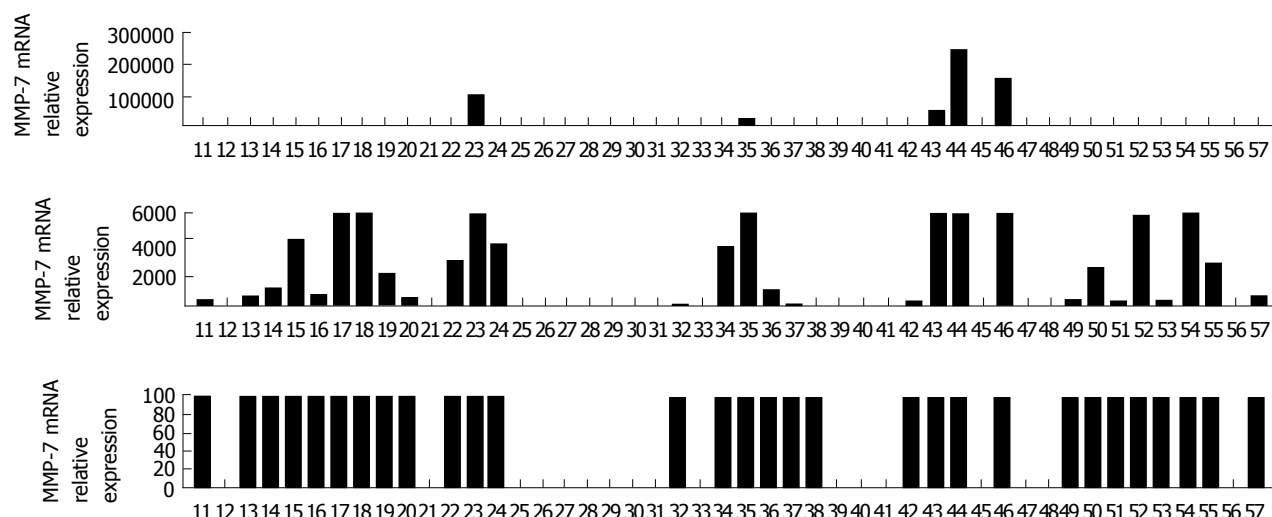


Figure 1 Patterns of expression of matrix metallo-proteinase-7 RNA transcripts in 47 peritoneal washing samples taken from 47 patients who had undergone surgery for colorectal cancer<sup>[45]</sup>. MMP: Matrix metallo-proteinase.

mechanism of the cell. DNA markers are used based on specific genetic abnormalities that occur in certain types of cancers, although it has been reported that, at least in some cases, disseminated tumor cells are not necessarily clonal to the primary tumor. In general, few chromosomal alterations specifically characterize certain types of cancer, or even are frequent enough to serve as molecular markers. The most frequently encountered genomic alterations in colorectal cancer, commonly used for the detection of free peritoneal cancer cells, include mutations in *k-Ras* and *p53* genes, sometimes investigated together with mRNA markers. More specifically, the detection of occult tumor cells engages targeting of tumor specific mRNA, meaning mRNA that encodes for antigens that are specific either for the malignant phenotype or for the normal tissue. The use of mRNA markers is based on the notion that tumor cells continue to display the same pattern of antigen expression as their normal tissue of origin. Once released from malignant cells, mRNA is relatively unstable; therefore, once detected, mRNA markers are indicative of the presence of viable tumor cells in the examined sample<sup>[43]</sup>.

In a recent meta-analysis, positive peritoneal washing was seen as an independent prognostic factor for poor survival and was associated with a greater risk of both local and systemic recurrence in colorectal cancer patients<sup>[44]</sup>. Yield rates of intraperitoneal neoplastic cells ranged from 5% to 40% depending on the methods and on the time of detection. In general, immunocytochemistry appears to result in a far greater yield of intraperitoneal neoplastic cells than either PCR or cytopathology. Furthermore it must be considered that immunocytochemistry (along with other histological staining techniques) is subjective and depends on the strength of cellular staining, while PCR-based methods have inherent problems as they detect DNA, not viable cells, and cannot delineate cancerous cells from

nonmalignant cells or cellular debris.

However, several cancer cell proteins may be identified by mean of PCR based methods, such as the matrix metallo-proteinase (MMP) class and specifically the MMP-7 (Figure 1) which has been recently proved a highly sensible predictive factor involved in colorectal cancer recurrence after curative treatment. In a recent article by Sica *et al.*<sup>[45]</sup> expression of MMP-7 on IFCC correlated with higher recurrence rate after curative surgery for colorectal cancer and worse prognosis<sup>[45]</sup>. Patterns of expression of MMP-7 RNA transcripts in a sample of 47 patients who underwent surgery for colorectal cancer are shown in Figure 1.

## CLINICAL AND PROGNOSTIC SIGNIFICANCE

In the last ten years, several studies attempted to state the prognostic and clinical meaning of free peritoneal cancer cells found during colorectal cancer surgery, investigating either their presence and prognostic impact<sup>[26,38-40,42,43,46]</sup>.

If their clinical importance in gastric cancer has been clearly identified<sup>[47-51]</sup>, results from this large series of studies on colorectal cancer are misleading. The first concern has to be moved to the large heterogeneity of detection techniques used: If conventional cytology appears to be very sensitive, easily applicable and low costing, its specificity is low, yielding positive results in 4% to 35.5% of series, also providing for a 2% of inconclusive examinations<sup>[42]</sup>. Immunoassays and PCR seem to be more specific as well as more expensive and subject to laboratory availability<sup>[37]</sup>.

This variability partially explains the differences in results from the studies. A recently closed large trial by French authors, based on 1364 patients, found no relationship between positive cytology and incidence

of recurrence and no predictive value regarding the development of peritoneal carcinomatosis. In this study positive cytology correlated with depth of invasion of colorectal wall, synchronous presence of minimal peritoneal carcinomatosis, lymph nodes metastasis, presence of ascites or not radical surgery; this reflected on survival analysis which led to worse survival in patients with positive cytology ( $P < 0.001$ ) in univariate analysis although it didn't reach statistical significance as independent prognostic factor<sup>[40]</sup>. Otherwise, other studies found higher risk of overall and loco-regional recurrence when peritoneal free cancer cells are found<sup>[39]</sup> as well as predictive of poorer outcome<sup>[38]</sup>.

Two studies showed that poorer outcomes are associated with positive post resection washing compared to positive pre-resection one, in terms of recurrence<sup>[52]</sup> and survival<sup>[36]</sup>.

In most studies, increasing disease staging correspond to higher rates of positive cytology<sup>[53]</sup> although they can be detected also in early stage patients<sup>[54]</sup>, mostly in stage 2, where Lloyd *et al.*<sup>[36]</sup> found worse survival among stage 2 patients with positive cytology rather than negative ones.

Some authors found correlation between positive cytology and poorly differentiated cancers<sup>[55]</sup> while the correlation with mucinous or signet ring cells histology remains unclear, even because these histological types are mostly found in advanced stage diseases.

When positive cytology is found, a prophylactic intraperitoneal chemotherapy may be considered in selected cases within clinical trials.

This proactive treatment is proposed in order to prevent peritoneal diffusion in colorectal cancer patients at high risk of peritoneal metastasis. The risk factors which were identified are as follow: Mucinous or signet ring cell hystologies, T3/T4 or perforated tumors and positive peritoneal cytology.

Two recent comparative studies by Sammartino *et al.*<sup>[18,19]</sup> showed that on a sample of 25 patients affected by colorectal cancer at high risk of peritoneal metastasis, a more aggressive surgical treatment including omentectomy, appendectomy, hepatic round ligament resection and oophorectomy in non-fertile women, associated with prophylactic intraperitoneal hyperthermic chemotherapy led to better disease free survival and lower peritoneal recurrence rates<sup>[18-20]</sup>. It is clear, at this point, that peritoneal washing should become a standardized procedure and that the clinical implications of IFCC are potentially enormous. Effort should be spent on obtaining reliable results in terms of sensibility and specificity of the methods of analysis.

## CONCLUSION

Positive peritoneal washing for IFCC is associated with worse outcome in colorectal cancer patients, however it is not clear whether it is associated with an increased risk of local recurrence or not. IFCC can be found in advanced stage or in the acute setting (occlusion or

perforation). However, positive cytology can occur also in colorectal cancer at an earlier stage (especially TNM stage II patients) and it could affect the strategic plan of treatment. Nevertheless, available data still do not allow to include peritoneal washing and cytology as routine procedures in staging colorectal cancer.

Potentially, peritoneal washing could improve the outcome of those selected patients with apparent early stage colorectal cancer, to receive adjuvant chemotherapy.

Patients with positive cytology may also become candidates to receive proactive intraperitoneal chemotherapy.

Peritoneal washing examination techniques must be improved in order to achieve a better sensitivity. It is the authors' belief that until a proper reliable tumor marker for RT-PCR will be identified, probably the most suitable procedure remains conventional cytology. However, giving the recent studies in this direction it is desirable that highly sensible proteins such as the MMP class and specifically the MMP-7 are employed to increase the specificity of conventional cytology<sup>[45]</sup>.

Further studies are needed to standardize detection and examination procedures, to determine if there are and which are the stages more likely to benefit from routine search for IFCC in the view of offering a proactive management, keeping in mind what Benjamin Franklin once stated: "an ounce of prevention is worth a pound of cure".

## REFERENCES

- 1 **Parkin DM**, Bray F, Ferlay J, Pisani P. Global cancer statistics, 2002. *CA Cancer J Clin* 2005; **55**: 74-108 [PMID: 15761078]
- 2 **Ferlay J**, Autier P, Boniol M, Heanue M, Colombet M, Boyle P. Estimates of the cancer incidence and mortality in Europe in 2006. *Ann Oncol* 2007; **18**: 581-592 [PMID: 17287242]
- 3 **Gellad ZF**, Provenzale D. Colorectal cancer: national and international perspective on the burden of disease and public health impact. *Gastroenterology* 2010; **138**: 2177-2190 [PMID: 20420954]
- 4 **Brodsky JT**, Cohen AM. Peritoneal seeding following potentially curative resection of colonic carcinoma: implications for adjuvant therapy. *Dis Colon Rectum* 1991; **34**: 723-727 [PMID: 1855433]
- 5 **Dukes CE**. The classification of cancer of the rectum. *J Pathol Bacteriol* 1932; **35**: 323-332
- 6 **Astler vb**, COLLIER FA. The prognostic significance of direct extension of carcinoma of the colon and rectum. *Ann Surg* 1954; **139**: 846-852 [PMID: 13159135]
- 7 **Hutter RV**. At last--worldwide agreement on the staging of cancer. *Arch Surg* 1987; **122**: 1235-1239 [PMID: 3675187]
- 8 **Sobin LH**, Hermanek P. eds. UICC International Union against Cancer TNM classification of malignant tumors 5th ed. New York: Wiley-Liss, 1997: 66-69
- 9 **Merkel S**, Mansmann U, Papadopoulos T, Wittekind C, Hohenberger W, Hermanek P. The prognostic inhomogeneity of colorectal carcinomas Stage III: a proposal for subdivision of Stage III. *Cancer* 2001; **92**: 2754-2759 [PMID: 11753948]
- 10 **Greene FL**, Stewart AK, Norton HJ. A new TNM staging strategy for node-positive (stage III) colon cancer: an analysis of 50,042 patients. *Ann Surg* 2002; **236**: 416-421; discussion 421 [PMID: 12368669]
- 11 **Liefers GJ**, Cleton-Jansen AM, van de Velde CJ, Hermans J, van Krieken JH, Cornelisse CJ, Tollenaar RA. Micrometastases and survival in stage II colorectal cancer. *N Engl J Med* 1998; **339**: 223-228 [PMID: 9673300]
- 12 **Esquivel J**, Sticca R, Sugarbaker P, Levine E, Yan TD, Alexander R,

- Baratti D, Bartlett D, Barone R, Barrios P, Bieligg S, BretchaBoix P, Chang CK, Chu F, Chu Q, Daniel S, de Bree E, Deraco M, Dominguez-Parra L, Elias D, Flynn R, Foster J, Garofalo A, Gilly FN, Glehen O, Gomez-Portilla A, Gonzalez-Bayon L, Gonzalez-Moreno S, Goodman M, Gushchin V, Hanna N, Hartmann J, Harrison L, Hoefer R, Kane J, Kecmanovic D, Kelley S, Kuhn J, Lamont J, Lange J, Li B, Loggie B, Mahteme H, Mann G, Martin R, Misih RA, Moran B, Morris D, Onate-Ocana L, Petrelli N, Philippe G, Pingpank J, Pitroff A, Piso P, Quinones M, Riley L, Rutstein L, Saha S, Alrawi S, Sardi A, Schneebaum S, Shen P, Shibata D, Spellman J, Stojadinovic A, Stewart J, Torres-Melero J, Tuttle T, Verwaal V, Villar J, Wilkinson N, Younan R, Zeh H, Zoetmulder F, Sebbag G. Cytoreductive surgery and hyperthermic intraperitoneal chemotherapy in the management of peritoneal surface malignancies of colonic origin: a consensus statement. Society of Surgical Oncology. *Ann Surg Oncol* 2007; **14**: 128-133 [PMID: 17072675]
- 13 **Sugarbaker PH.** Managing the peritoneal surface component of gastrointestinal cancer. Part 2. Perioperative intraperitoneal chemotherapy. *Oncology* (Williston Park) 2004; **18**: 207-219; discussion 220-222, 227-228, 230 [PMID: 15008058]
  - 14 **Sugarbaker PH.** Managing the peritoneal surface component of gastrointestinal cancer. Part 1. Patterns of dissemination and treatment options. *Oncology* (Williston Park) 2004; **18**: 51-59 [PMID: 14768406]
  - 15 **Glehen O**, Mithieux F, Osinsky D, Beaujard AC, Freyer G, Guertsch P, Francois Y, Peyrat P, Panteix G, Vignal J, Gilly FN. Surgery combined with peritonectomy procedures and intraperitoneal chemohyperthermia in abdominal cancers with peritoneal carcinomatosis: a phase II study. *J Clin Oncol* 2003; **21**: 799-806 [PMID: 12610177]
  - 16 **Sugarbaker PH**, Gianola FJ, Speyer JL, Wesley R, Barofsky I, Myers CE. Prospective randomized trial of intravenous v intraperitoneal 5-FU in patients with advanced primary colon or rectal cancer. *Semin Oncol* 1985; **12**: 101-111 [PMID: 3901269]
  - 17 **Goéré D**, Malka D, Tzanis D, Gava V, Boige V, Eveno C, Maggiori L, Dumont F, Ducreux M, Elias D. Is there a possibility of a cure in patients with colorectal peritoneal carcinomatosis amenable to complete cytoreductive surgery and intraperitoneal chemotherapy? *Ann Surg* 2013; **257**: 1065-1071 [PMID: 23299520 DOI: 10.1097/SLA.0b013e31827e9289]
  - 18 **Sammartino P**, Sibio S, Biacchi D, Cardi M, Mingazzini P, Rosati MS, Cornali T, Sollazzo B, Atta JM, Di Giorgio A. Long-term results after proactive management for locoregional control in patients with colonic cancer at high risk of peritoneal metastases. *Int J Colorectal Dis* 2014; **29**: 1081-1089 [PMID: 24980687 DOI: 10.1007/s00384-014-1929-4]
  - 19 **Sammartino P**, Sibio S, Biacchi D, Cardi M, Accarpio F, Mingazzini P, Rosati MS, Cornali T, Di Giorgio A. Prevention of Peritoneal Metastases from Colonic Cancer in High-Risk Patients: Preliminary Results of Surgery plus Prophylactic HIPEC. *Gastroenterol Res Pract* 2012; **2012**: 141585 [PMID: 22645605 DOI: 10.1155/2012/141585]
  - 20 **Sugarbaker PH.** Update on the prevention of local recurrence and peritoneal metastases in patients with colorectal cancer. *World J Gastroenterol* 2014; **20**: 9286-9291 [PMID: 25071322 DOI: 10.3748/wjg.v20.i28.9286]
  - 21 **Lowe E**, McKenna H. Peritoneal washing cytology: a retrospective analysis of 175 gynaecological patients. *Aust N Z J Obstet Gynaecol* 1989; **29**: 55-61 [PMID: 2487930]
  - 22 **Ziselman EM**, Harkavy SE, Hogan M, West W, Atkinson B. Peritoneal washing cytology. Uses and diagnostic criteria in gynecologic neoplasms. *Acta Cytol* 1984; **28**: 105-110 [PMID: 6583966]
  - 23 **Colgan TJ**, Boerner SL, Murphy J, Cole DE, Narod S, Rosen B. Peritoneal lavage cytology: an assessment of its value during prophylactic oophorectomy. *Gynecol Oncol* 2002; **85**: 397-403 [PMID: 12051865]
  - 24 **Nath J**, Moorthy K, Taniere P, Hallissey M, Alderson D. Peritoneal lavage cytology in patients with oesophagogastric adenocarcinoma. *Br J Surg* 2008; **95**: 721-726 [PMID: 18412292 DOI: 10.1002/bjs.6107]
  - 25 **Bentrem D**, Wilton A, Mazumdar M, Brennan M, Coit D. The value of peritoneal cytology as a preoperative predictor in patients with gastric carcinoma undergoing a curative resection. *Ann Surg Oncol* 2005; **12**: 347-353 [PMID: 15915368]
  - 26 **Vogel I**, Kalthoff H. Disseminated tumour cells. Their detection and significance for prognosis of gastrointestinal and pancreatic carcinomas. *Virchows Arch* 2001; **439**: 109-117 [PMID: 11561750]
  - 27 **Ceelen WP**, Bracke ME. Peritoneal minimal residual disease in colorectal cancer: mechanisms, prevention, and treatment. *Lancet Oncol* 2009; **10**: 72-79 [PMID: 19111247 DOI: 10.1016/S1470-2045(08)70335-8]
  - 28 **Kokenyesi R**, Murray KP, Benshushan A, Huntley ED, Kao MS. Invasion of interstitial matrix by a novel cell line from primary peritoneal carcinosarcoma, and by established ovarian carcinoma cell lines: role of cell-matrix adhesion molecules, proteinases, and E-cadherin expression. *Gynecol Oncol* 2003; **89**: 60-72 [PMID: 12694655]
  - 29 **McArdle CS**, McMillan DC, Hole DJ. The impact of blood loss, obstruction and perforation on survival in patients undergoing curative resection for colon cancer. *Br J Surg* 2006; **93**: 483-488 [PMID: 16555262]
  - 30 **Hansen E**, Wolff N, Knuechel R, Ruschoff J, Hofstaedter F, Taeger K. Tumor cells in blood shed from the surgical field. *Arch Surg* 1995; **130**: 387-393 [PMID: 7710337]
  - 31 **Lindberg U**, Karlsson R, Lassing I, Schutt CE, Höglund AS. The microfilament system and malignancy. *Semin Cancer Biol* 2008; **18**: 2-11 [PMID: 18024149]
  - 32 **Volz J**, Köster S, Spacek Z, Paweletz N. Characteristic alterations of the peritoneum after carbon dioxide pneumoperitoneum. *Surg Endosc* 1999; **13**: 611-614 [PMID: 10347302]
  - 33 **Jayne DG**, Guillo PJ, Thorpe H, Quirke P, Copeland J, Smith AM, Heath RM, Brown JM. Randomized trial of laparoscopic-assisted resection of colorectal carcinoma: 3-year results of the UK MRC CLASICC Trial Group. *J Clin Oncol* 2007; **25**: 3061-3068 [PMID: 17634484]
  - 34 **Heath RM**, Jayne DG, O'Leary R, Morrison EE, Guillo PJ. Tumour-induced apoptosis in human mesothelial cells: a mechanism of peritoneal invasion by Fas Ligand/Fas interaction. *Br J Cancer* 2004; **90**: 1437-1442 [PMID: 15054468]
  - 35 **Guller U**, Zajac P, Schnider A, Bösch B, Vorburger S, Zuber M, Spagnoli GC, Oertli D, Maurer R, Metzger U, Harder F, Heberer M, Marti WR. Disseminated single tumor cells as detected by realtime quantitative polymerase chain reaction represent a prognostic factor in patients undergoing surgery for colorectal cancer. *Ann Surg* 2002; **236**: 768-775; discussion 775-776 [PMID: 12454515]
  - 36 **Lloyd JM**, McIver CM, Stephenson SA, Hewett PJ, Rieger N, Hardingham JE. Identification of early-stage colorectal cancer patients at risk of relapse post-resection by immunobead reverse transcription-PCR analysis of peritoneal lavage fluid for malignant cells. *Clin Cancer Res* 2006; **12**: 417-423 [PMID: 16428481]
  - 37 **Hara M**, Nakanishi H, Jun Q, Kanemitsu Y, Ito S, Mochizuki Y, Yamamura Y, Kadera Y, Tatematsu M, Hirai T, Kato T. Comparative analysis of intraperitoneal minimal free cancer cells between colorectal and gastric cancer patients using quantitative RT-PCR: possible reason for rare peritoneal recurrence in colorectal cancer. *Clin Exp Metastasis* 2007; **24**: 179-189 [PMID: 17487561]
  - 38 **Mohan HM**, O'Connor DB, O'Riordan JM, Winter DC. Prognostic significance of detection of microscopic peritoneal disease in colorectal cancer: a systematic review. *Surg Oncol* 2013; **22**: e1-e6 [PMID: 23481599 DOI: 10.1016/j.suronc.2013.01.001]
  - 39 **Rekhras S**, Aziz O, Prabhudesai S, Zacharakis E, Mohr F, Athanasiou T, Darzi A, Ziprin P. Can intra-operative intraperitoneal free cancer cell detection techniques identify patients at higher recurrence risk following curative colorectal cancer resection: a meta-analysis. *Ann Surg Oncol* 2008; **15**: 60-68 [PMID: 17909914]
  - 40 **Cotte E**, Peyrat P, Piaton E, Chapuis F, Rivoire M, Glehen O, Arvieux C, Mabrut JY, Chipponi J, Gilly FN. Lack of prognostic significance of conventional peritoneal cytology in colorectal and gastric cancers: results of EVOCAPE 2 multicentre prospective



- study. *Eur J Surg Oncol* 2013; **39**: 707-714 [PMID: 23601984 DOI: 10.1016/j.ejso.2013.03.021]
- 41 **Spierer P**, Rossle M. Non gynecological cytopathology: a practical guide. Springer, 2012: 300-313
  - 42 **Passot G**, Mohkam K, Cotte E, Glehen O. Intra-operative peritoneal lavage for colorectal cancer. *World J Gastroenterol* 2014; **20**: 1935-1939 [PMID: 24616569 DOI: 10.3748/wjg.v20.i8.1935]
  - 43 **Tsouma A**, Aggeli C, Pissimissis N, Lembessis P, Zografos GN, Koutsilieris M. Circulating tumor cells in colorectal cancer: detection methods and clinical significance. *Anticancer Res* 2008; **28**: 3945-3960 [PMID: 19192655]
  - 44 **Bosanquet DC**, Harris DA, Evans MD, Beynon J. Systematic review and meta-analysis of intraoperative peritoneal lavage for colorectal cancer staging. *Br J Surg* 2013; **100**: 853-862 [PMID: 23536330 DOI: 10.1002/bjs.9118]
  - 45 **Sica GS**, Fiorani C, Stolfi C, Monteleone G, Candi E, Amelio I, Catani V, Sibio S, Divizia A, Tema G, Iaculli E, Gaspari AL. Peritoneal expression of Matrilysin helps identify early post-operative recurrence of colorectal cancer. *Oncotarget* 2015; **6**: 13402-13415 [PMID: 25596746]
  - 46 **Bosch B**, Guller U, Schnider A, Maurer R, Harder F, Metzger U, Marti WR. Perioperative detection of disseminated tumour cells is an independent prognostic factor in patients with colorectal cancer. *Br J Surg* 2003; **90**: 882-888 [PMID: 12854118]
  - 47 **La Torre M**, Ferri M, Giovagnoli MR, Sforza N, Cosenza G, Giarnieri E, Ziparo V. Peritoneal wash cytology in gastric carcinoma. Prognostic significance and therapeutic consequences. *Eur J Surg Oncol* 2010; **36**: 982-986 [PMID: 20591604]
  - 48 **Lorenzen S**, Panzram B, Rosenberg R, Nekarda H, Becker K, Schenk U, Höfler H, Siewert JR, Jäger D, Ott K. Prognostic significance of free peritoneal tumor cells in the peritoneal cavity before and after neoadjuvant chemotherapy in patients with gastric carcinoma undergoing potentially curative resection. *Ann Surg Oncol* 2010; **17**: 2733-2739 [PMID: 20490698]
  - 49 **Katsuragi K**, Yashiro M, Sawada T, Osaka H, Ohira M, Hirakawa K. Prognostic impact of PCR-based identification of isolated tumour cells in the peritoneal lavage fluid of gastric cancer patients who underwent a curative R0 resection. *Br J Cancer* 2007; **97**: 550-556 [PMID: 17667927]
  - 50 **Euanorasetr C**, Lertsithichai P. Prognostic significance of peritoneal washing cytology in Thai patients with gastric adenocarcinoma undergoing curative D2 gastrectomy. *Gastric Cancer* 2007; **10**: 18-23 [PMID: 17334713]
  - 51 **Homma Y**, Hamano T, Akazawa Y, Otsuki Y, Shimizu S, Kobayashi H, Kameoka S, Kobayashi Y. Positive peritoneal washing cytology is a potential risk factor for the recurrence of curatively resected colorectal cancer. *Surg Today* 2014; **44**: 1084-1089 [PMID: 23942820 DOI: 10.1007/s00595-013-0689-z]
  - 52 **Hase K**, Ueno H, Kuranaga N, Utsunomiya K, Kanabe S, Mochizuki H. Intraperitoneal exfoliated cancer cells in patients with colorectal cancer. *Dis Colon Rectum* 1998; **41**: 1134-1140 [PMID: 9749497]
  - 53 **Kanellos I**, Zacharakis E, Kanellos D, Pramateftakis MG, Betsis D. Prognostic significance of CEA levels and positive cytology in peritoneal washings in patients with colorectal cancer. *Colorectal Dis* 2006; **8**: 436-440 [PMID: 16684089]
  - 54 **Schott A**, Vogel I, Krueger U, Kalthoff H, Schreiber HW, Schmiegell W, Henne-Bruns D, Kremer B, Juhl H. Isolated tumor cells are frequently detectable in the peritoneal cavity of gastric and colorectal cancer patients and serve as a new prognostic marker. *Ann Surg* 1998; **227**: 372-379 [PMID: 9527060]
  - 55 **Gozalan U**, Yasti AC, Yuksek YN, Reis E, Kama NA. Peritoneal cytology in colorectal cancer: incidence and prognostic value. *Am J Surg* 2007; **193**: 672-675 [PMID: 17512274]

**P- Reviewer:** He S, Hironaka S, Noguera J, Wang YH

**S- Editor:** Ji FF **L- Editor:** A **E- Editor:** Li D





## Need for simulation in laparoscopic colorectal surgery training

Valerio Celentano

Valerio Celentano, Colorectal Unit, Federico II University, 80131 Naples, Italy

**Author contributions:** Celentano V solely contributed to this manuscript.

**Conflict-of-interest statement:** As a corresponding author I declare that there is no conflict of interest.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Correspondence to:** Dr. Valerio Celentano, Colorectal Unit, Federico II University, Via Pansini, 5, 80131 Naples, Italy. [valeriocelentano@yahoo.it](mailto:valeriocelentano@yahoo.it)  
Telephone: +39-33-95023785

Received: May 9, 2015

Peer-review started: May 11, 2015

First decision: June 2, 2015

Revised: June 30, 2015

Accepted: July 8, 2015

Article in press: July 8, 2015

Published online: September 27, 2015

human tissue and synthetic materials. Studies have even demonstrated an improvement in trainees' laparoscopic skills in the actual operating room and a staged approach to surgical simulation with a combination of various training methods should be mandatory in every colorectal training program. The learning curve for LCS could be reduced through practice and skills development in a riskfree setting.

**Key words:** Surgical simulation; Laparoscopic surgery; Surgical training; Colorectal surgery

© **The Author(s) 2015.** Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** Performing advanced laparoscopic procedures requires dedicated surgical skills and new simulation methods tailored precisely for laparoscopic colorectal surgery (LCS) have been established. This review focuses on a very actual topic in gastrointestinal surgery: The learning curve in minimally invasive surgery and the need for mechanisms to shorten the time needed for a trainee surgeon to safely move towards independent practice. This review article critically analyses the current role of simulation for LCS training.

Celentano V. Need for simulation in laparoscopic colorectal surgery training. *World J Gastrointest Surg* 2015; 7(9): 185-189 Available from: URL: <http://www.wjgnet.com/1948-9366/full/v7/i9/185.htm> DOI: <http://dx.doi.org/10.4240/wjgs.v7.i9.185>

### Abstract

The dissemination of laparoscopic colorectal surgery (LCS) has been slow despite increasing evidence for the clinical benefits, with a prolonged learning curve being one of the main restrictions for a prompt uptake. Performing advanced laparoscopic procedures requires dedicated surgical skills and new simulation methods designed precisely for LCS have been established: These include virtual reality simulators, box trainers, animal and

### INTRODUCTION

Laparoscopic colorectal surgery (LCS) has been increasingly applied because of its many advantages over conventional surgery, including reduced postoperative pain, earlier recovery of bowel function and shorter hospital stay<sup>[1]</sup>.

Despite the evidence for the clinical benefits of LCS

and its oncologic safety<sup>[2,3]</sup>, the dissemination of this technique has been hesitant, one of the main constraints for a swift uptake being an extended learning curve<sup>[4]</sup>.

The high level of technical complexity associated with laparoscopic colectomies was held partially responsible for its relatively low adoption rate when compared with other laparoscopic operations<sup>[5,6]</sup> and learning curves have been estimated as being between 30 and 60 cases<sup>[7,8]</sup> with the need to acquire specific skills dissimilar to those used during conventional surgery<sup>[9]</sup>.

LCS is a technically challenging procedure, frequently being self-taught by senior surgeons<sup>[10]</sup>, despite there is available evidence that the absence of appropriate training may lead to patient safety compromise<sup>[11]</sup>.

Nowadays, trainee surgeons are required to gather more technical skills in less time<sup>[12]</sup>. Research has demonstrated a deficiency of successful performance of enough critical laparoscopic colorectal cases by trainees<sup>[13,14]</sup>.

The proportion of operations undertaken by surgical trainees has reduced in the past decade<sup>[15]</sup> as they spend less time in theatre and more time covering nights and acute admissions<sup>[16,17]</sup>.

This gap between expected level and actual practice<sup>[18]</sup> has promoted the use of advanced training in laparoscopic colorectal surgery, with the evident need to improve the training opportunities available to trainees out-of-hours. Aim of this review is to summarize the different simulation strategies currently available for LCS training and the evidence demonstrating their advantages for colorectal trainees.

## NEW CHALLENGE FOR SURGICAL TRAINING

Surgical training has traditionally been one of apprenticeship, based on a Halsted's "see one, do one, teach one" classic scheme<sup>[19]</sup> where the surgical trainee learns to perform surgery under the supervision of an experienced surgeon.

Performing laparoscopic procedures requires special surgical skills to overcome the technical difficulties that it presents (Table 1), which include two-dimensional vision with loss of depth perception, less range of motion of the instruments when compared with open surgery, impaired tactile sensation, and the disparity between visual and proprioceptive feedback known as the fulcrum effect<sup>[21,22]</sup>. Laparoscopic surgery is difficult to learn by observation and practice alone<sup>[23]</sup> and competency requires dedicated training and mentoring<sup>[24]</sup>.

Moreover, augmented rates of adverse clinical outcomes at the beginning of the learning curve introduce ethical questions and emphasize the demand for mechanisms to decrease complications and unnecessary conversions to open surgery during the early stage of independent practice. As it is no longer accepted that surgeons acquire experience at the expense of patient safety, patients should not be exposed to the opportunity of harm when other training approaches are available for skill acquisition.

**Table 1 Distinctive features and challenges of laparoscopic surgery<sup>[20]</sup>**

Features	Challenges
Two dimensional vision	Reduced perception of depth
A disturbed eye-hand-target axis	Decreases ergonomics and dexterity
Long and inflexible instruments	Natural hand tremor magnified
Rigid instruments with five degrees of freedom	Decreased dexterity and range of motion
Fixed abdominal entry points	Limited freedom of motion and movement of the instrument:
	The fulcrum effect
Camera instability	Increased fatigue
Limited tactile feedback	Decreases dexterity

It has also been demonstrated that the surgical theatre can be a suboptimal place for beginner learning as high stress leads to deleterious effects on performance<sup>[25]</sup> and surgical training in the operating room implicates additional cost, estimated in approximately United States \$47979 per year per trainee<sup>[26]</sup>.

Concerns regarding cost, time, schedule restriction and safety have arisen and this forced surgeons to innovate and develop new methods of surgical training<sup>[27,28]</sup> and it became obvious that the learning curve must be abbreviated by learning outside of the surgical theatre<sup>[29]</sup>.

Committed practice on simulators corresponds with improved operative times and efficiency of movement for minimally invasive cholecystectomy. These results indicate that the learning curve for LCS may be reduced with this approach<sup>[30]</sup>. However, colonic and rectal resections performed laparoscopically are retained to be more difficult than a cholecystectomy as they involve added challenges like the need to operate within multiple quadrants in the abdominal cavity, the dissection of inflamed or obliterated tissue planes, and the safe mobilization of the bowel from confined spaces. LCS training is obviously less adapt to simple box trainers because of the necessity to work in multiple quadrants, transect and extract often large bulky specimens, and perform bowel anastomosis: Advanced surgery needs advanced simulation training.

Laparoscopic training not only has changed the traditional perspective challenging the Halsted's one century old apprenticeship model<sup>[31]</sup>, but has also induced a prompt development of simulation techniques given the versatility of the video environment and the capability to monitor the motions of the trainees. Adequate training clearly is the desirable way to prevent and diminish potential laparoscopic surgical errors<sup>[32]</sup>.

## SIMULATION PRACTICE IN LCS

New simulation methods designed peculiarly for LCS have been established (Table 2). These embrace a combination of virtual reality simulators and box trainers, animal and human tissue, and synthetic materials<sup>[33-36]</sup>.

Traditionally, animal and human cadaver training models have been utilized to improve spatial perception

**Table 2** Characteristics of the different types of simulators

Type of simulator	Main features
Box trainers	Low-cost, portable, can be used repeatedly by multiple users. Used to teach basic laparoscopic skills: hand-eye coordination, cutting, suturing, bimanual dexterity. Provide sensory feedback Requires direct observation and supervision by a trainer
Virtual reality simulators	Record several procedure metrics providing feedback to trainees. Recording of training performance for objective evidence of skill performance. Minor degree of sensory feedback and higher initial are the main disadvantages
Hybrid models	Reduced costs compared to cadaveric models. Questionable value of a training model with an alternative structure
Animal and human cadaveric models	Best anatomic and clinical-like model. Availability is limited and their use is expensive. Require operative facilities and a funeral service

of surgical anatomy<sup>[37,38]</sup>. This method of simulation is outstanding to demonstrate dissection, tissue handling and complex surgical techniques, but unfortunately, both these models require very specialized training environments, are very expensive with limited availability, and each trainee probably only gets to perform part of the procedure once.

Box-simulators use laparoscopic instruments set within a physical box. They provide tactile feedback and are relatively inexpensive, however require ongoing maintenance and materials, and require feedback from an observing trainer for maximum efficacy. Lack of availability of trainers and dedicated time for feedback may therefore limit this system.

Virtual reality simulators enable trainees to interface with a computer-generated environment that reproduces individual skills or entire procedures. Modern virtual reality simulators utilize increasingly advanced hardware and software for complex and realistic simulation: They have an higher initial cost but are valuable not only as a training device but also as a tool to assess surgical skills. In fact they provide pre-task tutorials and feedbacks at the completion of the procedure on a range of outputs such as time taken, efficiency of motion and knot integrity. Virtual reality simulator systems are convenient for the trainer as performance of the trainee can be monitored easily and remotely, meaning this system can be well utilized out-of-hours.

## FUTURE PERSPECTIVES

Several studies have demonstrated that training in laparoscopic techniques in a simulated setting, including on virtual-reality simulators, has enhanced the capabilities of the surgical trainees during and beyond the course of their training<sup>[39,40]</sup>. Some studies have even shown an

amelioration in trainees' laparoscopic skills in the actual surgical theatre<sup>[41,42]</sup> and it is now largely accepted that laparoscopic simulation training should be mandatory<sup>[43]</sup> to facilitate trainees acquire basic laparoscopic skills, and a growing consensus by regulation training bodies is desirable.

Proficiency-based simulator curricula have proven effective in improving the performance of trainees. An assessment of baseline skills level on laparoscopic colectomy for trainee surgeons may be used to fashion a tailored program dedicated to improve specific competences and to meet the needs of novice surgeons according to their specific pre-training skills.

Skills of different complexity can be achieved using a phased approach and a mixture of distinct simulation training techniques. Basic surgical competences such instrument handling and suturing should be developed in box trainers and virtual reality simulators, while advanced key steps in complex procedure mastered using torso-shaped mannequin with synthetic materials. Finally, as LCS requires cooperation among the surgeon, the assistants and the operating team personnel, advanced laparoscopy team training should be done in animal/cadaver/hybrid labs with a minimal number of required animals or cadavers.

## CONCLUSION

Training in LCS requires specific psychomotor skills that trainee surgeons are required to gather in less time. Simulation may offer a safe, reproducible environment for development of technical skills and procedural knowledge. The learning curve for LCS could be reduced through practice and skills development in a risk-free setting and a staged approach to simulation training should be mandatory in every colorectal training program.

## REFERENCES

1. **Guillou PJ**, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM, Heath RM, Brown JM. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet* 2005; **365**: 1718-1726 [PMID: 15894098 DOI: 10.1016/s0140-6736(05)66545-2]
2. **Faiz O**, Warusavitarne J, Bottle A, Tekkis PP, Darzi AW, Kennedy RH. Laparoscopically assisted vs. open elective colonic and rectal resection: a comparison of outcomes in English National Health Service Trusts between 1996 and 2006. *Dis Colon Rectum* 2009; **52**: 1695-1704 [PMID: 19966600 DOI: 10.1007/dcr.0b013e3181b55254]
3. **Hewett PJ**, Allardyce RA, Bagshaw PF, Frampton CM, Frizelle FA, Rieger NA, Smith JS, Solomon MJ, Stephens JH, Stevenson AR. Short-term outcomes of the Australasian randomized clinical study comparing laparoscopic and conventional open surgical treatments for colon cancer: the ALCCaS trial. *Ann Surg* 2008; **248**: 728-738 [PMID: 18948799 DOI: 10.1097/sla.0b013e31818b7595]
4. **Miskovic D**, Ni M, Wyles SM, Tekkis P, Hanna GB. Learning curve and case selection in laparoscopic colorectal surgery: systematic review and international multicenter analysis of 4852 cases. *Dis Colon Rectum* 2012; **55**: 1300-1310 [PMID: 23135590 DOI: 10.1097/dcr.0b013e31826ab4dd]

- 5 **Bardakcioglu O**, Khan A, Aldridge C, Chen J. Growth of laparoscopic colectomy in the United States: analysis of regional and socioeconomic factors over time. *Ann Surg* 2013; **258**: 270-274 [PMID: 23598378 DOI: 10.1097/sla.0b013e31828faa66]
- 6 **Kemp JA**, Finlayson SR. Nationwide trends in laparoscopic colectomy from 2000 to 2004. *Surg Endosc* 2008; **22**: 1181-1187 [PMID: 18246394 DOI: 10.1007/s00464-007-9732-8]
- 7 **Tekkis PP**, Senagore AJ, Delaney CP, Fazio VW. Evaluation of the learning curve in laparoscopic colorectal surgery: comparison of right-sided and left-sided resections. *Ann Surg* 2005; **242**: 83-91 [PMID: 15973105 DOI: 10.1097/01.sla.0000167857.14690.68]
- 8 **Choi DH**, Jeong WK, Lim SW, Chung TS, Park JI, Lim SB, Choi HS, Nam BH, Chang HJ, Jeong SY. Learning curves for laparoscopic sigmoidectomy used to manage curable sigmoid colon cancer: single-institute, three-surgeon experience. *Surg Endosc* 2009; **23**: 622-628 [PMID: 18270771 DOI: 10.1007/s00464-008-9753-y]
- 9 **Kim J**, Edwards E, Bowne W, Castro A, Moon V, Gadangi P, Ferzli G. Medial-to-lateral laparoscopic colon resection: a view beyond the learning curve. *Surg Endosc* 2007; **21**: 1503-1507 [PMID: 17641928 DOI: 10.1007/s00464-006-9085-8]
- 10 **Miskovic D**, Wyles SM, Ni M, Darzi AW, Hanna GB. Systematic review on mentoring and simulation in laparoscopic colorectal surgery. *Ann Surg* 2010; **252**: 943-951 [PMID: 21107103 DOI: 10.1097/sla.0b013e3181f662e5]
- 11 A prospective analysis of 1518 laparoscopic cholecystectomies. The Southern Surgeons Club. *N Engl J Med* 1991; **324**: 1073-1078 [PMID: 1826143 DOI: 10.1056/nejm199104183241601]
- 12 **Stein S**, Stulberg J, Champagne B. Learning laparoscopic colectomy during colorectal residency: what does it take and how are we doing? *Surg Endosc* 2012; **26**: 488-492 [PMID: 21938581 DOI: 10.1007/s00464-011-1906-8]
- 13 **Bass BL**. Matching training to practice: the next step. *Ann Surg* 2006; **243**: 436-438 [PMID: 16552192 DOI: 10.1097/01.sla.0000205222.95167.a4]
- 14 **Pugh CM**, Darosa DA, Bell RH. Residents' self-reported learning needs for intraoperative knowledge: are we missing the bar? *Am J Surg* 2010; **199**: 562-565 [PMID: 20359575 DOI: 10.1016/j.amjsurg.2009.11.003]
- 15 **Blencowe NS**, Parsons BA, Hollowood AD. Effects of changing work patterns on general surgical training over the last decade. *Postgrad Med J* 2011; **87**: 795-799 [PMID: 21984742 DOI: 10.1136/postgradmedj-2011-130297]
- 16 **Varley I**, Keir J, Fagg P. Changes in caseload and the potential impact on surgical training: a retrospective review of one hospital's experience. *BMC Med Educ* 2006; **6**: 6 [PMID: 16420692 DOI: 10.1186/1472-6920-6-6]
- 17 **Taylor IA**, Alexander F. Preface to the ISCP report. ISCP Evaluation Task Group, 2006. Available from: URL: <http://www.mee.nhs.uk/pdf/FinalReportISCP-MichaelEraut.pdf>
- 18 **Bell RH**, Biester TW, Tabuenca A, Rhodes RS, Cofer JB, Britt LD, Lewis FR. Operative experience of residents in US general surgery programs: a gap between expectation and experience. *Ann Surg* 2009; **249**: 719-724 [PMID: 19387334 DOI: 10.1097/sla.0b013e3181a38e59]
- 19 **Kerr B**, O'Leary JP. The training of the surgeon: Dr. Halsted's greatest legacy. *Am Surg* 1999; **65**: 1101-1102 [PMID: 10551765]
- 20 **Heemskerck J**, Zandbergen R, Maessen JG, Greve JW, Bouvy ND. Advantages of advanced laparoscopic systems. *Surg Endosc* 2006; **20**: 730-733 [PMID: 16528462 DOI: 10.1007/s00464-005-0456-3]
- 21 **Scott DJ**, Young WN, Tesfay ST, Frawley WH, Rege RV, Jones DB. Laparoscopic skills training. *Am J Surg* 2001; **182**: 137-142 [PMID: 11574084 DOI: 10.1016/s0002-9610(01)00669-9]
- 22 **Smith CD**, Farrell TM, McNatt SS, Metreveli RE. Assessing laparoscopic manipulative skills. *Am J Surg* 2001; **181**: 547-550 [PMID: 11513783]
- 23 **Dutta S**, Gaba D, Krummel TM. To simulate or not to simulate: what is the question? *Ann Surg* 2006; **243**: 301-303 [PMID: 16495691 DOI: 10.1097/01.sla.0000200853.69108.6d]
- 24 **Celentano V**, Finch D, Forster L, Robinson JM, Griffith JP. Safety of supervised trainee-performed laparoscopic surgery for inflammatory bowel disease. *Int J Colorectal Dis* 2015; **30**: 639-644 [PMID: 25669758 DOI: 10.1007/s00384-015-2147-4]
- 25 **Park J**, MacRae H, Musselman LJ, Rossos P, Hamstra SJ, Wolman S, Reznick RK. Randomized controlled trial of virtual reality simulator training: transfer to live patients. *Am J Surg* 2007; **194**: 205-211 [PMID: 17618805 DOI: 10.1016/j.amjsurg.2006.11.032]
- 26 **Bridges M**, Diamond DL. The financial impact of teaching surgical residents in the operating room. *Am J Surg* 1999; **177**: 28-32 [PMID: 10037304 DOI: 10.1016/s0002-9610(98)00289-x]
- 27 **Gurusamy KS**, Aggarwal R, Palanivelu L, Davidson BR. Virtual reality training for surgical trainees in laparoscopic surgery. *Cochrane Database Syst Rev* 2009; **21**: CD006575 [PMID: 19160288 DOI: 10.1002/14651858.cd006575]
- 28 **Scott DJ**, Bergen PC, Rege RV, Laycock R, Tesfay ST, Valentine RJ, Euhus DM, Jeyarajah DR, Thompson WM, Jones DB. Laparoscopic training on bench models: better and more cost effective than operating room experience? *J Am Coll Surg* 2000; **191**: 272-283 [PMID: 10989902 DOI: 10.1016/s1072-7515(00)00339-2]
- 29 **Samia H**, Khan S, Lawrence J, Delaney CP. Simulation and its role in training. *Clin Colon Rectal Surg* 2013; **26**: 47-55 [PMID: 24436648 DOI: 10.1055/s-0033-1333661]
- 30 **Aggarwal R**, Ward J, Balasundaram I, Sains P, Athanasiou T, Darzi A. Proving the effectiveness of virtual reality simulation for training in laparoscopic surgery. *Ann Surg* 2007; **246**: 771-779 [PMID: 17968168 DOI: 10.1097/sla.0b013e3180f61b09]
- 31 **Halsted WS**. The training of the surgeon. *Bull Johns Hopkins Hosp* 1904; **15**: 267-276
- 32 **Moore MJ**, Bennett CL. The learning curve for laparoscopic cholecystectomy. The Southern Surgeons Club. *Am J Surg* 1995; **170**: 55-59 [PMID: 7793496 DOI: 10.1016/s0002-9610(99)80252-9]
- 33 **Bashankaev B**, Baido S, Wexner SD. Review of available methods of simulation training to facilitate surgical education. *Surg Endosc* 2011; **25**: 28-35 [PMID: 20552373 DOI: 10.1007/s00464-010-1123-x]
- 34 **Roberts KE**, Bell RL, Duffy AJ. Evolution of surgical skills training. *World J Gastroenterol* 2006; **12**: 3219-3224 [PMID: 16718842]
- 35 **Waseda M**, Inaki N, Mailaender L, Buess GF. An innovative trainer for surgical procedures using animal organs. *Minim Invasive Ther Allied Technol* 2005; **14**: 262-266 [PMID: 16754173 DOI: 10.1080/13645700500273841]
- 36 **Ramshaw BJ**, Young D, Garcha I, Shuler F, Wilson R, White JG, Duncan T, Mason E. The role of multimedia interactive programs in training for laparoscopic procedures. *Surg Endosc* 2001; **15**: 21-27 [PMID: 11178755 DOI: 10.1007/s004640000319]
- 37 **Ross HM**, Simmang CL, Fleshman JW, Marcello PW. Adoption of laparoscopic colectomy: results and implications of ASCRS hands-on course participation. *Surg Innov* 2008; **15**: 179-183 [PMID: 18757376 DOI: 10.1177/1553350608322100]
- 38 **Katz R**, Hoznek A, Antiphon P, Van Velthoven R, Delmas V, Abbou CC. Cadaveric versus porcine models in urological laparoscopic training. *Urol Int* 2003; **71**: 310-315 [PMID: 14512654 DOI: 10.1159/000072684]
- 39 **Grantcharov TP**, Kristiansen VB, Bendix J, Bardram L, Rosenberg J, Funch-Jensen P. Randomized clinical trial of virtual reality simulation for laparoscopic skills training. *Br J Surg* 2004; **91**: 146-150 [PMID: 14760660 DOI: 10.1002/bjs.4407]
- 40 **Gallagher AG**, Ritter EM, Champion H, Higgins G, Fried MP, Moses G, Smith CD, Satava RM. Virtual reality simulation for the operating room: proficiency-based training as a paradigm shift in surgical skills training. *Ann Surg* 2005; **241**: 364-372 [PMID: 15650649 DOI: 10.1097/01.sla.0000151982.85062.80]
- 41 **Hyltander A**, Liljegren E, Rhodin PH, Lönnroth H. The transfer of basic skills learned in a laparoscopic simulator to the operating room. *Surg Endosc* 2002; **16**: 1324-1328 [PMID: 11988802]
- 42 **Seymour NE**, Gallagher AG, Roman SA, O'Brien MK, Bansal VK, Andersen DK, Satava RM. Virtual reality training improves operating room performance: results of a randomized, double-blinded study. *Ann Surg* 2002; **236**: 458-463; discussion 463-464

- [PMID: 12368674]  
43 **Zimmerman H**, Latifi R, Dehdashti B, Ong E, Jie T, Galvani C, Waer A, Wynne J, Biffar D, Gruessner R. Intensive laparoscopic

## Celentano V. Simulation in colorectal surgery

training course for surgical residents: program description, initial results, and requirements. *Surg Endosc* 2011; **25**: 3636-3641 [PMID: 21643881 DOI: 10.1007/s00464-011-1770-6]

**P- Reviewer:** Fukunaga Y, Lakatos PL  
**S- Editor:** Ji FF **L- Editor:** A **E- Editor:** Li D





## Management of afferent loop obstruction: Reoperation or endoscopic and percutaneous interventions?

Konstantinos Blouhos, Konstantinos Andreas Boulas, Konstantinos Tsalis, Anestis Hatzigeorgiadis

Konstantinos Blouhos, Konstantinos Andreas Boulas, Anestis Hatzigeorgiadis, Department of General Surgery, General Hospital of Drama, 66100 Drama, Greece

Konstantinos Tsalis, D' Surgical Department, "G. Papanikolaou" Hospital, Medical School, Aristotle University of Thessaloniki, 54645 Thessaloniki, Greece

**Author contributions:** Blouhos K designed the research; Boulas KA performed the literature research and wrote the paper; Hatzigeorgiadis A substantially contributed in editing the English language of the manuscript; Tsalis K and Hatzigeorgiadis A made critical revisions related to important intellectual content of the manuscript and had the final approval of the version of the article to be published.

**Conflict-of-interest statement:** None.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Correspondence to:** Konstantinos Andreas Boulas, MD, MSc, Department of General Surgery, General Hospital of Drama, End of Hippokratous Street, 66100 Drama, Greece. [katerinantwna@hotmail.com](mailto:katerinantwna@hotmail.com)  
Telephone: +30-693-7265675  
Fax: +30-251-3501559

Received: March 23, 2015  
Peer-review started: March 26, 2015  
First decision: June 3, 2015  
Revised: June 21, 2015  
Accepted: July 21, 2015  
Article in press: July 23, 2015  
Published online: September 27, 2015

### Abstract

Afferent loop obstruction is a purely mechanical complication that infrequently occurs following construction of a gastrojejunostomy. The operations most commonly associated with this complication are gastrectomy with Billroth II or Roux-en-Y reconstruction, and pancreaticoduodenectomy with conventional loop or Roux-en-Y reconstruction. Etiology of afferent loop obstruction includes: (1) entrapment, compression and kinking by postoperative adhesions; (2) internal herniation, volvulus and intussusception; (3) stenosis due to ulceration at the gastrojejunostomy site and radiation enteritis of the afferent loop; (4) cancer recurrence; and (5) enteroliths, bezoars and foreign bodies. Acute afferent loop obstruction is associated with complete obstruction of the afferent loop and represents a surgical emergency, whereas chronic afferent loop obstruction is associated with partial obstruction. Abdominal multiple detector computed tomography is the diagnostic study of choice. CT appearance of the obstructed afferent loop consists of a C-shaped, fluid-filled tubular mass located in the midline between the abdominal aorta and the superior mesenteric artery with valvulae conniventes projecting into the lumen. The cornerstone of treatment is surgery. Surgery includes: (1) adhesiolysis and reconstruction for benign causes; and (2) by-pass or excision and reconstruction for malignant causes. However, endoscopic enteral stenting, transhepatic percutaneous enteral stenting and direct percutaneous tube enterostomy have the principal role in management of malignant and radiation-induced obstruction. Nevertheless, considerable limitations exist as a former Roux-en-Y reconstruction limits endoscopic access to the afferent loop and percutaneous approaches for enteral stenting and tube enterostomy have only been reported in the literature as isolated cases.

**Key words:** Afferent loop; Obstruction; Reoperation; Endoscopy; Enterostomy

© The Author(s) 2015. Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** Management strategy of afferent loop obstruction (ALO) depends on: (1) the benign or malignant nature of the obstruction. ALO caused by a benign lesion needs definitive repair of the primary cause by surgery. ALO caused by a malignant lesion needs palliative treatment (percutaneous and endoscopic interventions, by-pass surgery) or excision; and (2) the site of obstruction. An obstruction at the inframesocolic portion of the afferent loop can be easily reconstructed, whereas an obstruction at the supramesocolic portion needs copious mobilization and may require revision of the hepaticojejunostomy or pancreaticojejunostomy and/or a modified Puestow procedure in the setting of a preceded pancreaticoduodenectomy.

Blouhos K, Boulas KA, Tsalis K, Hatzigeorgiadis A. Management of afferent loop obstruction: Reoperation or endoscopic and percutaneous interventions? *World J Gastrointest Surg* 2015; 7(9): 190-195 Available from: URL: <http://www.wjgnet.com/1948-9366/full/v7/i9/190.htm> DOI: <http://dx.doi.org/10.4240/wjgs.v7.i9.190>

## DEFINITIONS

Creation of a gastrojejunostomy leaves a segment of proximal small bowel, most commonly consisting of duodenum and proximal jejunum, lying upstream from the gastrojejunostomy. This limb of intestine conducts bile, pancreatic juices, and other proximal intestinal secretions toward the gastrojejunostomy and is termed the afferent loop<sup>[1]</sup>. Afferent loop obstruction (ALO) is a purely mechanical complication that infrequently occurs following construction of a gastrojejunostomy. The operations most commonly associated with this complication include total gastrectomy with loop esophagojejunostomy and simple or pouch Roux-en-Y reconstruction, partial gastrectomy with Billroth II and Roux-en-Y reconstruction, and pancreaticoduodenectomy with conventional loop and Roux-en-Y reconstruction performed for treatment of benign and malignant causes<sup>[2]</sup>.

## ETIOLOGY

Causes of ALO include: (1) Entrapment, compression and kinking of the afferent loop by postoperative adhesions<sup>[3]</sup>; (2) Internal herniation, volvulus and intussusception of the afferent loop<sup>[4]</sup>; (3) Scarring due to marginal ulceration of the gastrojejunostomy<sup>[5]</sup>; (4) Locoregional recurrence (lymph nodes, peritoneum, gastric remnant, anastomotic sites)<sup>[6]</sup>; (5) Radiation enteritis of the afferent loop<sup>[7]</sup>; and (6) Enteroliths, bezoars and foreign bodies impacted in the afferent loop<sup>[8]</sup>. The causes of ALO can be classified according to the benign or malignant nature of the obstructing lesion to emphasize the presentation, natural history and management

of ALO (Table 1). Risk factors for ALO include: (1) Redundant (longer than 30-40 cm) and antecolic afferent loops which are more prone to kinking, volvulus, and entrapment by adhesions; and (2) Improperly closed mesocolic defects which predispose to internal herniation of the retrocolic afferent loop<sup>[9]</sup>.

## INCIDENCE

The incidence of ALO after distal gastrectomy with Billroth II or Roux-en-Y reconstruction has been reported to be 0.3%-1.0%<sup>[10]</sup>. Although there are several specific predisposing factors for ALO following laparoscopic gastrectomy such as partial omentectomy and antecolic anastomosis, the incidence of ALO after open and laparoscopic surgery is similar. Kim *et al.*<sup>[11]</sup> in their retrospective cohort study, reported 4 (1.01%) patients who developed ALO among 386 gastric cancer patients submitted to laparoscopic distal gastrectomy with Billroth II reconstruction. The interval between the initial gastrectomy and the operation for ALO ranged from 4 to 540 d (median 33 d). The causes of ALO included adhesions in 2 patients and internal herniation in 2 patients. All patients recovered following emergency operations<sup>[11]</sup>. Aoki *et al.*<sup>[12]</sup> in their retrospective cohort study, reported 4 (0.2%) patients who developed ALO among 1908 gastric cancer patients submitted to distal gastrectomy with Roux-en-Y reconstruction. The causes of the ALO included internal herniation in two patients, adhesions in one patient, and peritoneal recurrence in one patient. The interval between the initial gastrectomy and emergency operations for ALO ranged from 3 wk to 2 years (median 5 mo). All patients recovered following emergency operations.

There are limited data on the incidence of ALO after pancreaticoduodenectomy, especially among long-term pancreatic cancer survivors (> 2 years). In one of the few studies in the literature, Pannala *et al.*<sup>[13]</sup> evaluated the incidence of ALO in pancreatic cancer patients submitted to pancreaticoduodenectomy. Pannala *et al.*<sup>[13]</sup> in their retrospective cohort study, reported 24 (13%) patients who developed ALO among 186 pancreatic cancer patients treated with pancreaticoduodenectomy. Median time to diagnosis was 1.2 years (range 0.03-12.3 years). Obstruction was primarily caused by recurrent pancreatic cancer in 8 patients (33%) and radiation enteritis of the afferent loop in 9 patients (38%)<sup>[13]</sup>.

## PATHOPHYSIOLOGY

Symptoms associated with ALO are attributed to the increased intraluminal pressure and distention due to accumulation of enteric, biliary and pancreatic secretions in the partially or completely obstructed afferent loop. The severity of symptoms mainly depends on the degree and duration of obstruction<sup>[14]</sup>. Acute ALO represents a closed-loop obstruction and can be complicated by: (1) Ischemia and gangrene of the completely obstructed afferent loop with subsequent perforation and peritonitis; and (2) Ascending cholangitis and pancreatitis. Chronic

**Table 1** Classification of afferent loop obstruction and management strategy

Causes			Management
Benign	Intraluminal	Foreign bodies	Surgery <sup>[2]</sup>
		Bezoar	
		Enteroliths	
	Intussusception	Intussusception	
		Gastrojejunostomy	
	Extrinsic	ulceration	
Malignant	Recurrence	Adhesions	Endoscopy for enteral stenting <sup>[32]</sup> Transhepatic percutaneous enteral stenting or direct percutaneous tube enterostomy <sup>[29]</sup> By-pass surgery <sup>[2]</sup>
		Volvulus	
		Internal hernia	
		Gastric remnant	
		Anastomotic sites	
		Lymph nodes	
Radiation enteritis		Peritoneum	Excision of the former afferent loop and reconstruction <sup>[31,33]</sup>
		Carcinomatosis	

ALO represents an open-loop obstruction and can be complicated by: (1) Events similar to those seen in closed-loop obstruction despite the fact that the partially obstructed afferent loop can be partially decompressed; (2) Ascending cholangitis and pancreatitis; and (3) Bacterial overgrowth which can lead to steatorrhea, malnutrition, and vitamin B-12 deficiency<sup>[15]</sup>.

## PRESENTATION

The primary symptoms of patients with acute ALO are sudden, severe abdominal pain and vomiting. The pain often occurs before associated findings of localized abdominal tenderness and involuntary guarding develop. When physical findings develop, there is a high level of suspicion that the viability of the bowel is compromised. Consequently, when ALO is the most likely diagnosis, abdominal pain out of proportion to physical findings represents a surgical emergency. The vomitus is not bilious because the biliary and pancreatic secretions remain trapped in the obstructed afferent loop<sup>[16]</sup>.

Chronic ALO is more difficult to diagnose than acute ALO. Chronic ALO may manifest as periumbilical discomfort developing 15-30 min after eating and often lasting 1 to 4 h. These patients develop food fear and modify their pattern of eating so that they only consume small quantity of food. Patients with chronic ALO almost always have a profound weight loss, which raises suspicion of intraabdominal malignancy. The progression from open-loop obstruction which is characterized by minor symptoms to closed-loop obstruction which represent a true surgical emergency is unpredictable. Projectile bilious vomiting may occur as the distended afferent loop decompresses forcefully providing rapid relief of symptoms. Chronic ALO with stasis and bacterial overgrowth can be further complicated by steatorrhea, diarrhea, B-12 and iron deficiency anemia<sup>[17]</sup>.

Physical examination can reveal one or more of the following findings: (1) Upper abdominal distention. An ill-defined mass in the upper abdomen may be palpated representing the completely obstructed afferent loop; (2) Localized upper abdominal tenderness and involuntary

guarding if perforation and peritonitis have occurred; (3) Jaundice; and (4) Signs of pancreatitis.

## IMAGING STUDIES

Prior to the era of CT, conventional upper gastrointestinal barium studies were used to assess ALO. Two classical findings of ALO were described: (1) Non-filling of the afferent loop; and (2) Retention of barium in the dilated afferent loop for at least 60 min. However, several limitations existed as 20% of normal afferent loops were not filled with a barium meal and the underlying cause of obstruction was poorly identified<sup>[18]</sup>.

CT plays a key role in the diagnosis of ALO. Zissin *et al*<sup>[19]</sup> reported that the characteristic CT appearance of the obstructed afferent loop is a U or C-shaped, fluid-filled, 5.3 cm in average diameter, tubular mass (C-loop sign) located in the midline between the abdominal aorta and the superior mesenteric artery with valvulae conniventes projecting into the lumen (keyboard sign) which can help in the differential diagnosis of pancreatic pseudocysts. Juan *et al*<sup>[20]</sup> reviewed multiple detector computed tomography scans of 22 patients who developed ALO after partial gastrectomy and pancreaticoduodenectomy. The C-loop appearance was present in 22 patients (100%) and the keyboard sign in 21 patients (95%) (Figure 1). There was only 1 patient without the presence of the keyboard sign due to bowel perforation. The maximal diameter of the afferent loop ranged from 3.3 to 5.8 cm.

CT images should be evaluated for the presence of: (1) the C-loop sign; (2) the keyboard sign; (3) pancreaticobiliary tract dilatation; (4) bowel wall thickening at the anastomotic sites, the afferent and efferent loops; and (5) lymphadenopathy, ascites, peritoneal enhancement, and metastatic lesions. Adhesions are suspected when a point of transition from a dilated to a normal-caliber loop is observed without other apparent cause. An internal hernia is suspected when crowding, stretching, and crossover of mesenteric vessels and the whirl sign are observed. Local recurrence and radiation enteritis are suspected when focal and diffuse bowel wall



Figure 1 C-loop (black arrow) and the keyboard sign (white arrows).

thickening are observed, respectively. Carcinomatosis is suspected when ascites and peritoneal enhancement are present and bowel wall thickening around the level of obstruction is absent<sup>[21]</sup>. Kim *et al*<sup>[22]</sup> reviewed helical CT scans of 18 patients who developed ALO after partial gastrectomy. The presumed cause of obstruction on CT was compared with surgical findings and clinical courses. In all 8 patients who underwent a second operation the cause of afferent loop was correctly suggested on CT. In all 10 patients who were not re-explored, the clinical findings or biopsy indicated recurrent tumor as suggested on CT. The authors concluded that CT correctly predicted the causes of ALO<sup>[22]</sup>.

Diagnostic evaluation of ALO in the setting of a preceded pancreaticoduodenectomy should embrace magnetic resonance cholangiopancreatography (MRCP) or secretin-enhanced MRCP. The incidence of biliary and pancreatic stricture after pancreaticoduodenectomy is 2.6% and 2%, respectively. The patency of the primary hepaticojejunostomy and pancreaticojejunostomy should be thoroughly evaluated because the presence of a stricture can alter management strategy of ALO. Anatomic variants (pancreas divisum, dominant dorsal duct, aberrant ductal communications) and ductal pathology including filling defects, stenosis or obstruction should be recorded<sup>[23]</sup>. A hepaticojejunostomy stricture is characterized by the presence of a fixed filling defect at the anastomotic site, along with post-obstructive extra- and intra-hepatic ductal dilation. A pancreaticojejunostomy stricture is characterized by the presence of a fixed filling defect at the anastomotic site, along with post-obstructive ductal dilation, side-branch enhancement and/or decreased functional excretion into the jejunal drainage limb<sup>[24]</sup>.

## MANAGEMENT

As ALO is an infrequent complication after gastrectomy and pancreaticoduodenectomy, the literature on management of this complication is limited and much of the current knowledge is derived by the accrual of single-institution series. Management strategy (Table 2) depends on the following three factors: (1) The benign or malignant nature of the obstructing lesion. ALO

caused by benign lesions needs definitive treatment by surgery with the exception of anastomotic ulcerations which can be managed by endoscopic balloon dilation. Surgery includes repair of the primary cause along with a form of afferent loop reconstruction including: Addition of a Braun anastomosis in a former Billroth II reconstruction, excision of the redundant loop and conversion of Billroth II to Roux-en-Y gastrojejunostomy, and excision of the redundant loop and reconstruction of the former Roux-en-Y jejunojejunostomy. ALO caused by malignant lesions needs primarily palliative treatment (percutaneous and endoscopic interventions, by-pass surgery) and secondarily surgery with curative intent (excision and reconstruction); (2) The site of obstruction. An obstruction at the inframesocolic portion of the afferent loop can be easily reconstructed, whereas an obstruction at the supramesocolic portion of the afferent loop needs copious mobilization of the supramesocolic segment of the afferent loop through a field of dense adhesions; and (3) The patency of the primary hepaticojejunostomy and pancreaticojejunostomy. ALO in the setting of a preceded pancreaticoduodenectomy may require revision of the hepaticojejunostomy and pancreaticojejunostomy and/or a modified Puestow procedure during reconstruction of the obstructed afferent loop due to an anastomotic stenosis demonstrated in the preoperative secretin-enhanced MRCP<sup>[25]</sup>.

As mentioned above, surgery has the principal role in the management of benign ALO. On the contrary, palliative approaches are preferred in the setting of malignant ALO as in the literature there are no data showing differences in survival between patients who submitted to palliative and curative treatment for management of malignant ALO. Endoscopic interventions at the afferent loop (balloon dilation, double-pigtail stents traversing the afferent loop strictured area, balloon dilation and double-pigtail stent placement, afferent loop metal stent placement), the bile duct (biliary balloon dilation and plastic or metal stent placement through ERCP), and the pancreatic duct (pancreatic duct balloon dilation and stent placement through ERCP or EUS-guided rendezvous drainage after unsuccessful ERCP) have the principal role in the management of malignant ALO<sup>[26]</sup>. In Pannala *et al*<sup>[13]</sup> series, fifteen patients (62%) had an endoscopic intervention for management of malignant ALO after pancreaticoduodenectomy with Billroth II reconstruction for pancreatic cancer. These patients required a median of 2 endoscopic procedures (range 1-17 endoscopic procedures); eleven patients (73%) had clinical and laboratory improvement, two patients (13%) did not improve, and two patients (13%) were lost to follow-up<sup>[13]</sup>. However, a Roux-en-Y reconstruction limits endoscopic access to the afferent loop<sup>[27]</sup>. Enteral stenting and ERCP with double-balloon enteroscope in patients with Roux-en-Y anastomosis have only been reported in small single-institute series<sup>[28]</sup>. Moreover, transhepatic enteral stent insertion and direct percutaneous tube enterostomy for management of ALO have only been reported in the literature as isolated



**Table 2** Management of afferent loop obstruction

Causes		Management	
		Former Billroth II	Former Roux-en-Y
Benign	Enteroliths	Endoscopy and balloon dilation of anastomotic stenosis <sup>[34]</sup> or adhesiolysis, enterotomy, removal and repair of anastomotic stenosis (stricturoplasty, addition of Braun anastomosis, conversion to Roux-en-Y) <sup>[8,16]</sup>	Endoscopy and balloon dilation of anastomotic stenosis or adhesiolysis, enterotomy, removal and repair of anastomotic stenosis (stricturoplasty, revision of the Roux-en-Y reconstruction)
	Bezoar		
	Foreign bodies		
	Intussusception	Manual reduction or enterectomy and conversion to Roux-en-Y <sup>[4]</sup>	Manual reduction or enterectomy and revision of Roux-en-Y reconstruction
	Anastomotic ulceration	Balloon dilation <sup>[34]</sup> , stricturoplasty or conversion to Roux-en-Y	Balloon dilation, stricturoplasty or revision of the Roux-en-Y reconstruction
	Adhesions	Adhesiolysis, Braun anastomosis or excision of redundant loop and conversion to Roux-en-Y <sup>[35]</sup>	Adhesiolysis, excision of redundant loop and revision of the jejunojejunostomy
	Volvulus	Enterectomy and conversion to Roux-en-Y <sup>[36]</sup>	Enterectomy and revision of the Roux-en-Y reconstruction
Malignant	Internal hernia	Reduction and repair of the defect or reduction, repair of the defect, enterectomy and conversion to Roux-en-Y <sup>[37]</sup>	Reduction and repair of the defect or reduction, repair of the defect, enterectomy and revision of the Roux-en-Y reconstruction
	Radiation enteritis	Endoscopy for enteral stenting <sup>[32]</sup>	Double-balloon endoscopy for enteral stenting
		Transhepatic percutaneous enteral stenting or direct percutaneous tube enterostomy <sup>[38]</sup>	Transhepatic percutaneous enteral stenting or direct percutaneous tube enterostomy
		Redo-surgery when other approaches fail: By-pass <sup>[2]</sup>	Redo-surgery when other approaches fail: By-pass
		Adhesiolysis, mobilization and excision of the afferent loop, Roux-en-Y reconstruction	Adhesiolysis, mobilization and excision of the afferent loop, revision of the Roux-en-Y reconstruction
		In preceded pancreaticoduodenectomy assessment of HJ and PJ patency with MRCP. Revision of the strictured HJ, revision of the strictured PJ and/or modified Puestow <sup>[31]</sup> or pancreaticojejunostomy if primary PJ has normal patency <sup>[33]</sup>	In preceded pancreaticoduodenectomy assessment of HJ and PJ patency with MRCP. Revision of the strictured HJ, revision of the strictured PJ and/or modified Puestow or pancreaticojejunostomy if primary PJ has normal patency

HJ: Hepaticojejunostomy; PJ: Pancreaticojejunostomy; MRCP: Magnetic resonance cholangiopancreatography.

cases<sup>[29]</sup>.

When endoscopic and percutaneous approaches are neither successful nor feasible for management of malignant ALO, redo surgery becomes inevitable. Reoperative surgery is a difficult undertaking and reoperation itself may be the cause of further morbidity and mortality. Reoperation rates vary from 4% to 11% among small-volume series<sup>[30]</sup>. When redo surgery is indicated, more conservative surgical approaches, such as by-pass surgery, should be performed in this challenging group of patients. When all the above approaches (percutaneous and endoscopic interventions, by-pass surgery) fail, excision of the obstructed afferent loop and reconstruction should be considered as a treatment option<sup>[31]</sup>.

## REFERENCES

- Woodfield CA, Levine MS. The postoperative stomach. *Eur J Radiol* 2005; **53**: 341-352 [PMID: 15741008 DOI: 10.1016/j.ejrad.2004.12.009]
- Bolton JS, Conway WC. Postgastrectomy syndromes. *Surg Clin North Am* 2011; **91**: 1105-1122 [PMID: 21889032 DOI: 10.1016/j.suc.2011.07.001]
- Uchida H, Sakamoto S, Hamano I, Kobayashi M, Kitajima T, Shigeta T, Kanazawa H, Fukuda A, Kasahara M. Urgent living donor liver transplantation for biliary atresia complicated by a strangulated internal hernia at Roux-en Y limb: a case report. *Ann Transplant* 2014; **19**: 149-152 [PMID: 24675002 DOI: 10.12659/AOT.890213]
- Lee SY, Lee JC, Yang DH. Early Postoperative Retrograde Jejunojejunal Intussusception after Total Gastrectomy with Roux-en-Y Esophagojejunostomy: A Case Report. *J Gastric Cancer* 2013; **13**: 263-265 [PMID: 24511423 DOI: 10.5230/jgc.2013.13.4.263]
- Ballas KD, Rafailidis SE, Konstantinidis HD, Pavlidis TE, Marakis GN, Anagnostara E, Sakadakis AK. Acute afferent loop syndrome: a true emergency. A case report. *Acta Chir Belg* 2009; **109**: 101-103 [PMID: 19341207]
- Yoshida H, Mamada Y, Tanai N, Mizuguchi Y, Kakinuma D, Ishikawa Y, Nakamura Y, Okuda T, Kiyama T, Tajiri T. Afferent loop obstruction treated by percutaneous transhepatic insertion of an expandable metallic stent. *Hepatogastroenterology* 2008; **55**: 1767-1769 [PMID: 19102388]
- Blouhos K, Boulas KA, Salpigkitis II, Konstantinidou A, Ioannidis K, Hatzigeorgiadis A. Total Reconstruction of the Afferent Loop for Treatment of Radiation-Induced Afferent Loop Obstruction with Segmental Involvement after Pancreaticoduodenectomy with Roux-en-Y Reconstruction. *Case Rep Oncol* 2013; **6**: 424-429 [PMID: 24019782 DOI: 10.1159/000354576]
- Sarli L, Iusco D, Violi V, Roncoroni L. Enterolith ileus complicating afferent loop syndrome simulating acute pancreatitis. *Int Surg* 2003; **88**: 129-132 [PMID: 14584766]
- De Martino C, Caiazzo P, Albano M, Pastore M, Tramutoli PR, Rocca R, Botte M, Sigillito A. Acute afferent loop obstruction treated by endoscopic decompression. Case report and review of literature. *Ann Ital Chir* 2012; **83**: 555-558 [PMID: 23110908]
- Grisé K, McFadden D. Anastomotic technique influences outcomes after partial gastrectomy for adenocarcinoma. *Am Surg* 2001; **67**: 948-950 [PMID: 11603551]
- Kim DJ, Lee JH, Kim W. Afferent loop obstruction following laparoscopic distal gastrectomy with Billroth-II gastrojejunostomy. *J Korean Surg Soc* 2013; **84**: 281-286 [PMID: 23646313 DOI: 10.1007/s00268-013-2811-1]



- 10.4174/jkss.2013.84.5.281]
- 12 **Aoki M**, Saka M, Morita S, Fukagawa T, Katai H. Afferent loop obstruction after distal gastrectomy with Roux-en-Y reconstruction. *World J Surg* 2010; **34**: 2389-2392 [PMID: 20458583 DOI: 10.1007/s00268-010-0602-5]
  - 13 **Pannala R**, Brandabur JJ, Gan SI, Gluck M, Irani S, Patterson DJ, Ross AS, Dorer R, Traverso LW, Picozzi VJ, Kozarek RA. Afferent limb syndrome and delayed GI problems after pancreaticoduodenectomy for pancreatic cancer: single-center, 14-year experience. *Gastrointest Endosc* 2011; **74**: 295-302 [PMID: 21689816 DOI: 10.1016/j.gie.2011.04.029]
  - 14 **Vettoretto N**, Pettinato G, Romessis M, Bravo AF, Barozzi G, Giovanetti M. Laparoscopy in afferent loop obstruction presenting as acute pancreatitis. *JSLs* 2006; **10**: 270-274 [PMID: 16882437]
  - 15 **Rana SV**, Bhardwaj SB. Small intestinal bacterial overgrowth. *Scand J Gastroenterol* 2008; **43**: 1030-1037 [PMID: 18609165 DOI: 10.1080/00365520801947074]
  - 16 **Lee MC**, Bui JT, Knuttinen MG, Gaba RC, Scott Helton W, Owens CA. Enterolith causing afferent loop obstruction: a case report and literature review. *Cardiovasc Intervent Radiol* 2009; **32**: 1091-1096 [PMID: 19365684 DOI: 10.1007/s00270-009-9561-3]
  - 17 **Kwong WT**, Fehmi SM, Lowy AM, Savides TJ. Enteral stenting for gastric outlet obstruction and afferent limb syndrome following pancreaticoduodenectomy. *Ann Gastroenterol* 2014; **27**: 413-417 [PMID: 25332208]
  - 18 **Sandrasegaran K**, Maglinte DD. Imaging of small bowel-related complications following major abdominal surgery. *Eur J Radiol* 2005; **53**: 374-386 [PMID: 15741011 DOI: 10.1016/j.ejrad.2004.12.017]
  - 19 **Zissin R**. CT findings of afferent loop syndrome after a subtotal gastrectomy with Roux-en-Y reconstruction. *Emerg Radiol* 2004; **10**: 201-203 [PMID: 15290491 DOI: 10.1007/s10140-003-0309-0]
  - 20 **Juan YH**, Yu CY, Hsu HH, Huang GS, Chan DC, Liu CH, Tung HJ, Chang WC. Using multidetector-row CT for the diagnosis of afferent loop syndrome following gastroenterostomy reconstruction. *Yonsei Med J* 2011; **52**: 574-580 [PMID: 21623598 DOI: 10.3349/ymj.2011.52.4.574]
  - 21 **Zissin R**, Osadchy A, Gayer G. Abdominal CT findings of delayed postoperative complications. *Can Assoc Radiol J* 2007; **58**: 200-211 [PMID: 18186431]
  - 22 **Kim HC**, Han JK, Kim KW, Kim YH, Yang HK, Kim SH, Won HJ, Lee KH, Choi BI. Afferent loop obstruction after gastric cancer surgery: helical CT findings. *Abdom Imaging* 2003; **28**: 624-630 [PMID: 14628863 DOI: 10.1007/s00261-002-0070-y]
  - 23 **Czakó L**, Takács T, Morvay Z, Csernay L, Lonovics J. Diagnostic role of secretin-enhanced MRCP in patients with unsuccessful ERCP. *World J Gastroenterol* 2004; **10**: 3034-3038 [PMID: 15378788]
  - 24 **Lomanto D**, Pavone P, Laghi A, Panebianco V, Mazzocchi P, Fiocca F, Lezoche E, Passariello R, Speranza V. Magnetic resonance-cholangiopancreatography in the diagnosis of biliopancreatic diseases. *Am J Surg* 1997; **174**: 33-38 [PMID: 9240949 DOI: 10.1016/S0002-9610(97)00022-6]
  - 25 **Demirjian AN**, Kent TS, Callery MP, Vollmer CM. The inconsistent nature of symptomatic pancreatico-jejunoanastomotic strictures. *HPB (Oxford)* 2010; **12**: 482-487 [PMID: 20815857 DOI: 10.1111/j.1477-2574.2010.00214.x]
  - 26 **Kim HJ**, Park JY, Bang S, Park SW, Lee YC, Song SY. Selfexpandable metal stents for recurrent malignant obstruction after gastric surgery. *Hepatogastroenterology* 2009; **56**: 914-917 [PMID: 19621728]
  - 27 **Hintze RE**, Adler A, Veltzke W, Abou-Rebyeh H. Endoscopic access to the papilla of Vater for endoscopic retrograde cholangiopancreatography in patients with Billroth II or Roux-en-Y gastrojejunostomy. *Endoscopy* 1997; **29**: 69-73 [PMID: 9101141 DOI: 10.1055/s-2007-1004077]
  - 28 **Sasaki T**, Isayama H, Kogure H, Yamada A, Aoki T, Kokudo N, Koike K. Double-balloon enteroscope-assisted enteral stent placement for malignant afferent-loop obstruction after Roux-en-Y reconstruction. *Endoscopy* 2014; **46** Suppl 1 UCTN: E541-E542 [PMID: 25409061 DOI: 10.1055/s-0034-1377633]
  - 29 **Laasch HU**. Obstructive jaundice after bilioenteric anastomosis: transhepatic and direct percutaneous enteral stent insertion for afferent loop occlusion. *Gut Liver* 2010; **4** Suppl 1: S89-S95 [PMID: 21103301 DOI: 10.5009/gnl.2010.4.S1.S89]
  - 30 **Reddy JR**, Saxena R, Singh RK, Pottakkat B, Prakash A, Behari A, Gupta AK, Kapoor VK. Reoperation following Pancreaticoduodenectomy. *Int J Surg Oncol* 2012; **2012**: 218248 [PMID: 23008765 DOI: 10.1155/2012/218248]
  - 31 **Morgan KA**, Fontenot BB, Harvey NR, Adams DB. Revision of anastomotic stenosis after pancreatic head resection for chronic pancreatitis: is it futile? *HPB (Oxford)* 2010; **12**: 211-216 [PMID: 20590889 DOI: 10.1111/j.1477-2574.2009.00154.x]
  - 32 **Burdick JS**, Garza AA, Magee DJ, Dykes C, Jeyarajah R. Endoscopic management of afferent loop syndrome of malignant etiology. *Gastrointest Endosc* 2002; **55**: 602-605 [PMID: 11923786 DOI: 10.1067/mge.2002.122584]
  - 33 **Blouhos K**, Boulas KA, Tsiomita E, Papageorgiou I, Ioannidis K, Hatzigeorgiadis A. Pancreaticojejunostomy during reconstruction of the afferent loop in surgery of radiation-induced afferent loop obstruction following pancreaticoduodenectomy with Roux-en-Y reconstruction. *Updates Surg* 2014; **66**: 51-57 [PMID: 24254381 DOI: 10.1007/s13304-013-0238-8]
  - 34 **Yasuda A**, Imamoto H, Furukawa H, Imano M, Yasuda T, Okuno K. [Two cases of afferent loop syndrome caused by obstruction at the jejuno-jejunoanastomosis site in the Roux-en-Y loop that were successfully treated by endoscopic balloon dilatation]. *Gan To Kagaku Ryoho* 2014; **41**: 2322-2325 [PMID: 25731510]
  - 35 **Spiliotis J**, Karnabatidis D, Vaxevanidou A, Datsis AC, Rogdakis A, Zacharis G, Siambilis D. Acute cholangitis due to afferent loop syndrome after a Whipple procedure: a case report. *Cases J* 2009; **2**: 6339 [PMID: 19918578 DOI: 10.4076/1757-1626-2-6339]
  - 36 **Fleser PS**, Villalba M. Afferent limb volvulus and perforation of the bypassed stomach as a complication of Roux-en-Y gastric bypass. *Obes Surg* 2003; **13**: 453-456 [PMID: 12841911 DOI: 10.1381/096089203765887831]
  - 37 **Kaya E**, Senyürek G, Dervisoglu A, Danaci M, Kesim M. Acute pancreatitis caused by afferent loop herniation after Billroth II gastrectomy: report of a case and review of the literature. *Hepatogastroenterology* 2004; **51**: 606-608 [PMID: 15086215]
  - 38 **Chevallier P**, Novellas S, Motamedi JP, Gugenheim J, Brunner P, Bruneton JN. Percutaneous jejunostomy and stent placement for treatment of malignant Roux-en-Y obstruction: a case report. *Clin Imaging* 2006; **30**: 283-286 [PMID: 16814147 DOI: 10.1016/j.clinimag.2006.02.008]

**P- Reviewer:** Konishi T, Kozarek R, Morgagni P  
**S- Editor:** Tian YL **L- Editor:** A **E- Editor:** Li D



## Basic Study

## Response to chemoradiotherapy and lymph node involvement in locally advanced rectal cancer

Luis J García-Flórez, Guillermo Gómez-Álvarez, Ana M Frunza, Luis Barneo-Serra, Manuel F Fresno-Forcelledo

Luis J García-Flórez, General and Digestive Surgery Service, Hospital San Agustín, 33401 Avilés, Spain

Luis J García-Flórez, Luis Barneo-Serra, Manuel F Fresno-Forcelledo, Department of Surgery, University of Oviedo, 33006 Oviedo, Spain

Guillermo Gómez-Álvarez, Ana M Frunza, Coloproctology Section, General Surgery, Hospital Universitario Central de Asturias, 33011 Oviedo, Spain

Manuel F Fresno-Forcelledo, Pathology, Hospital Universitario Central de Asturias, 33011 Oviedo, Spain

**Author contributions:** García-Flórez LJ, Gómez-Álvarez G, Barneo-Serra L and Fresno-Forcelledo MF contributed to study design; García-Flórez LJ and Frunza AM contributed to data acquisition; García-Flórez LJ and Gómez-Álvarez G contributed to manuscript preparation; García-Flórez LJ, Gómez-Álvarez G, Frunza AM, Barneo-Serra L and Fresno-Forcelledo MF contributed to manuscript editing and review.

**Institutional review board statement:** The study was reviewed and approved by the HUCA (Hospital Universitario Central de Asturias) Review Board.

**Conflict-of-interest statement:** There are no conflicts of interest.

**Data sharing statement:** Dataset available from the corresponding author at: [luisjgf@gmail.com](mailto:luisjgf@gmail.com).

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Correspondence to:** Luis J García-Flórez, MD, PhD, Associate Professor of Surgery, General and Digestive Surgery Service, Hospital San Agustín, Camino de Heros s/n, 33401

Avilés, Spain. [luisjgf@gmail.com](mailto:luisjgf@gmail.com)  
Telephone: +34-985-123000  
Fax: +34-985-123010

Received: May 15, 2015  
Peer-review started: May 20, 2015  
First decision: July 10, 2015  
Revised: July 15, 2015  
Accepted: August 10, 2015  
Article in press: August 11, 2015  
Published online: September 27, 2015

### Abstract

**AIM:** To establish the association between lymph node involvement and the response to neoadjuvant therapy in locally advanced rectal cancer.

**METHODS:** Data of 130 patients with mid and low locally advanced rectal adenocarcinoma treated with neoadjuvant chemoradiation followed by radical surgery over a 5-year period were reviewed. Tumor staging was done by endorectal ultrasound and/or magnetic resonance imaging. Tumor response to neoadjuvant therapy was determined by T-downstaging and tumor regression grading (TRG). Pathologic complete response (pCR) is defined as the absence of tumor cells in the surgical specimen (ypT0N0). The varying degrees TRG were classified according to Mandard's scoring system. The evaluation of the response is based on the comparison between previous clinico-radiological staging and the results of pathological evaluation.  $\chi^2$  and Spearman's correlation tests were used for the comparison of variables.

**RESULTS:** Pathologic complete response (pCR, ypT0N0, TRG1) was observed in 19 cases (14.6%), and other 18 (13.8%) had only very few residual malignant cells in the rectal wall (TRG2). T-downstaging was found in 63 (48.5%). Mean lymph node retrieval was 9.4 (range

0-38). In 37 cases (28.5%) more than 12 nodes were identified in the surgical specimen. Preoperative lymph node involvement was seen in 77 patients (59.2%), 71 N1 and 6 N2. Postoperative lymph node involvement was observed in 41 patients (31.5%), 29 N1 and 12 N2, while the remaining 89 were N0 (68.5%). In relation to ypT stage, we found nodal involvement of 9.4% in ypT0-1, 22.2% in ypT2 and 43.7% in ypT3-4. Of the 37 patients considered "responders" to neoadjuvant therapy (TRG1 and 2), there were only 4 N+ (10.8%) and the remainder N0 (89.2%). In the "non responders" group (TRG 3, 4 and 5), 37 cases were N+ (39.8%) and 56 (60.2%) were N0 ( $P < 0.001$ ).

**CONCLUSION:** Response to neoadjuvant chemoradiation in rectal cancer is associated with lymph node involvement.

**Key words:** Response to treatment; Neoadjuvant therapy; Rectal cancer; Chemoradiotherapy; Lymph node involvement

© The Author(s) 2015. Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** The treatment of rectal cancer has evolved significantly in recent decades. The response of the primary tumor to neoadjuvant therapy, measured by tumor regression grading, seems to be a good prognostic factor, although this relationship is controversial. One of the most important prognostic factors is lymph node stage, but its relationship with the response to neoadjuvant therapy has not been studied extensively. In our series the response is correlated with lymph node involvement in the surgical specimens. Tumor regression grading score could therefore have clinical implications in the future in order to provide tailored therapies.

García-Flórez LJ, Gómez-Álvarez G, Frunza AM, Barneo-Serra L, Fresno-Forcelledo MF. Response to chemoradiotherapy and lymph node involvement in locally advanced rectal cancer. *World J Gastrointest Surg* 2015; 7(9): 196-202 Available from: URL: <http://www.wjgnet.com/1948-9366/full/v7/i9/196.htm> DOI: <http://dx.doi.org/10.4240/wjgs.v7.i9.196>

## INTRODUCTION

Colorectal cancer is one of the most common tumors worldwide, both in males and females, with an estimated 600000 deaths per year<sup>[1]</sup>. About 70% are located in the colon and 30% in the rectum. The treatment of rectal cancer (RC) has evolved significantly in recent decades. Neoadjuvant therapy with chemoradiation (CRT) improves local control and reduces toxicity compared to postoperative therapies. Sauer *et al*<sup>[2]</sup> showed that neoadjuvant CRT is superior in terms of local recurrence (LR) and acute toxicity. Around 60% of these patients

experience some degree of tumor regression, but only a minor percentage will show pathologic complete response (pCR)<sup>[3]</sup>.

According to data from the German Rectal Cancer Study Group<sup>[4]</sup>, pCR is associated to better local control, lower risk of distant metastasis and better disease-free survival. The response of the primary tumor to neoadjuvant therapy, measured by tumor regression grading (TRG) seems to be a good prognostic factor, however this relationship is controversial. In some studies no association with survival was found<sup>[5,6]</sup>, whilst in others it was<sup>[7,8]</sup>. One of the most important prognostic factors is lymph node stage<sup>[9]</sup>, but its relationship with the response to neoadjuvant therapy has not been studied extensively.

The aim of this study was to establish the relationship between lymph node involvement and the response to neoadjuvant CRT in locally advanced RC.

## MATERIALS AND METHODS

### Sample population

Data of patients with mid and low locally advanced rectal adenocarcinoma treated with neoadjuvant CRT followed by radical surgery in the University Central Hospital of Asturias over a 5 year period were reviewed. Rectal location is divided into low (2 to 6 cm from anal verge) and mid rectum (7 to 12 cm) measured by rigid proctoscope or magnetic resonance imaging (MRI). Locally advanced RC is defined as a tumor extending beyond the rectal wall (T3-4) or with lymph node involvement (N+), according to the TNM classification of the UICC<sup>[10]</sup>, based on clinical and radiological criteria. Patients with skin or anal cancer, stage T1-2N0 RC, distal margin in upper rectum, with no completion of CRT or with previous pelvic radiotherapy were excluded of the study. Also excluded were those with no record of diagnostic endoscopic biopsy or those with no radical surgery. All patients received long course radiotherapy (45-50.4 Gy) with 5-FU based chemotherapy followed by radical surgery with total mesorectal excision (TME) after a mean of 7 wk interval.

### Pathological evaluation

Morphologic evaluation of the surgical specimens was carried out by two experienced pathologist with no knowledge of other clinical data. The evaluation of the response to neoadjuvant CRT is based on the comparison between previous clinico-radiological staging and the results of pathological evaluation, measuring T-downstaging and TRG. PCR is defined as the absence of tumor cells in the surgical specimen (ypTON0). T-downstaging was evidenced by TNM staging and is defined as the reduction of at least one T level measured initially by endorectal ultrasound and/or pelvic MRI and finally by pathological evaluation. The varying degrees of TRG were classified according to Mandard *et al*<sup>[11]</sup> scoring system.

**Table 1** Characteristics of the sample population (*n* = 130)

		<i>n</i> (%)
Age	Mean	67.4 ± 10.6
	Range	42-86
Gender	Male	87 (66.9)
	Female	43 (33.1)
Tumor location	Mid rectum	75 (57.7)
	Low rectum	55 (42.3)
Tumor differentiation	Well	68 (52.3)
	Moderate	53 (40.8)
	Poor	9 (6.9)
Staging method	Endorectal ultrasound	119 (91.5)
	Magnetic resonance imaging	47 (36.2)
Radiotherapy	45 Gy	84 (64.6)
	50.4 Gy	46 (35.4)
Interval to surgery	Mean	7.1 ± 1.1
	Range	5-12
Surgical procedures	Low anterior resection	55 (42.3)
	Abdominoperineal resection	47 (36.2)
	Hartmann procedure	25 (19.2)
	Total proctocolectomy	3 (2.3)

**Table 3** Postoperative pathologic evaluation (ypTN stage) (*n* = 130)

ypTN	<i>n</i>	%
T0N0	19	14.6
T1N0	10	7.7
T2N0	21	16.2
T3N0	38	29.2
T4N0	2	1.5
T0N1	3	2.3
T2N1	6	4.6
T3N1	16	12.3
T4N1	3	2.3
T3N2	11	8.5
T4N2	1	0.8

### Statistical analysis

For the statistical analysis the software SPSS Statistics v21 was used. Two groups were established: "Responders", including TRG1 and 2, and "non responders", including TRG3, 4 and 5.  $\chi^2$  and Spearman's correlation tests were used for the comparison of variables. A *P* below 0.05 was considered significant. The statistical review of the study was performed by an expert in biomedical statistics.

## RESULTS

A sample of 130 patients who met the study criteria was included (Table 1). All patients received full treatment with long cycle radiotherapy (45-50.4 Gy) and 5-FU based chemotherapy (oral capecitabine) followed by radical surgery.

For staging at baseline, endorectal ultrasound was available in 119 cases and pelvic MRI in 47. In early years of the study, the main staging method was ultrasound. Pelvic MRI is commonly used in recent years (Table 2). In case of disagreement between the two methods (10 cases), MRI was preferably considered.

**Table 2** Tumor staging

	<i>n</i>	%
Pelvic MRI ( <i>n</i> = 47)		
T3N1	21	44.6
T3N0	12	25.5
T3N2	4	8.5
T4N0	3	6.4
T4N1	3	6.4
T2N1	2	4.3
T4N2	2	4.3
ERUS ( <i>n</i> = 119)		
T3N1	53	44.6
T3N0	50	42
T4N1	9	7.6
T4N0	3	2.5
T2N1	3	2.5
T3N2	1	0.8

MRI: Magnetic resonance imaging; ERUS: Endorectal ultrasound.

**Table 4** Tumor regression grading according to Mandard *et al.*<sup>[11]</sup> scoring system

TRG	<i>n</i>	%
1	19	14.6
2	18	13.9
3	39	30
4	41	31.5
5	13	10

TRG: Tumor regression grading.

The ypTN (postoperative) staging is showed in Table 3.

The result of TRG is included in Table 4. Complete response (pCR, ypT0N0, TRG1) was observed in 19 cases (14.6%), and other 18 (13.8%) had only very few residual malignant cells in the rectal wall (TRG2). These two groups were considered "responders" to neoadjuvant therapy. T-downstaging was seen in 63 patients (48.5%) and progression of tumor stage only in one case.

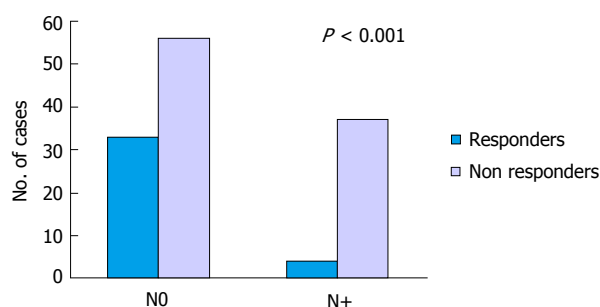
Mean lymph node retrieval was 9.4 (range 0-38). In 37 cases (28.5%) more than 12 nodes were identified in the surgical specimen. Preoperative lymph node involvement was seen in 77 patients (59.2%), 71 N1 and 6 N2. Postoperative lymph node involvement was observed in 41 patients (31.5%), 29 N1 and 12 N2, while the remaining 89 were N0 (68.5%). In relation to ypT stage, we found nodal involvement of 9.4% in ypT0-1, 22.2% in ypT2 and 43.7% in ypT3-4.

Of the 37 patients considered "responders" to neoadjuvant therapy (TRG1 and 2), there were only 4 N+ (10.8%) and the remainder N0 (89.2%). In the "non responders" group, 37 cases were N+ (39.8%) and 56 (60.2%) were N0 (*P* < 0.001) (Figure 1).

## DISCUSSION

Conventional treatment for locally advanced, clinically resectable (T3-4 and/or N+) tumors is neoadjuvant CRT followed by radical surgery. Our ability to identify the N+





**Figure 1** Correlation between ypN stage and tumor regression grading. Tumor regression grading according to Mandard *et al.*<sup>[11]</sup> scoring system.

is limited, which leads to potentially overtreat 15%-20% of patients, as the German Trial shows<sup>[2]</sup>, or undertreat 20%-30%. For N stage, both endorectal ultrasound and MRI have similar low sensitivity and specificity rates. Nonetheless, MRI is preferred for N-stage assessment because it allows the evaluation of the whole mesorectum. With radiological imaging advances we have progressed in the identification of adjuvant and neoadjuvant therapy needs. High resolution pelvic MRI with expert radiologist interpretation would help us to select patients that will be correctly treated with just surgery<sup>[12]</sup>. We are now using MRI to be selective and only irradiate those with a big volume, threatened mesorectal fascia, significant N+ or those with signs of venous invasion. In this line, the prospect trial is investigating the possibility of selectively eliminating the use of neoadjuvant radiotherapy in patients with upper and mid RC<sup>[13]</sup>.

Response rates to CRT are highly variable. Approximately 15%-40% are resistant, while 5%-35% show a pCR. Our results are in that line. Pathological stage and TRG have a significant prognostic impact. Several studies link the TRG with disease-free survival but only pCR is clearly correlated<sup>[7,14]</sup>. TRG has been studied extensively. Rödel *et al.*<sup>[4]</sup> analyzed 385 cases and found significant differences when grouped TRG 2 and 3, but not when stratified by pathological stage, giving doubts about the exact significance of this factor. Losi *et al.*<sup>[15]</sup> found differences in 106 patients only when grouped TRG 3 and 4, although there was a trend towards improved disease-free survival when TRG was stratified by pathological stage. Moreno García *et al.*<sup>[16]</sup> found that both disease-free survival and overall survival significantly improved with increased TRG. However, the correlation of the response to neoadjuvant CRT and LR and survival is still controversial<sup>[17,18]</sup>.

In our series, we found a 14.6% of pCR. Patients with pCR have a better prognosis, with excellent local control and disease-free survival, regardless of previous TN stage<sup>[4,15,19-22]</sup>. Capirci *et al.*<sup>[23]</sup> reviewed a large series of 566 cases with pCR in 61 centers and found better prognosis in this group. A number of groups are currently studying the possibility of treating the RC when a complete clinical response is achieved with local excision or observation (wait and see approach).

Because approximately 40%-50% of patients treated with CRT will be ypT0-2 stage and a 10%-20% will be pCR (in our series 45.4% and 14.5% respectively), these preservation strategies of the rectum may have a potential application in many patients. However, there is a weak correlation between clinical and pathological response. Complete pathologic response cannot be accurately identified by clinical, endoscopic or radiological examination and, in most cases, is carried out with subjective exploration data<sup>[24-26]</sup>. One of the main questions that arise when performing local surgery is the nodal status. The incidence of lymph node involvement after neoadjuvant therapy varies. Some studies indicate differences in response between the tumor and the mesorectal lymph nodes<sup>[24,27]</sup>. The risk of lymph node involvement in patients treated with CRT and ypT0 tumors is low, but increases significantly with the degree of tumor penetration if any residual neoplastic cells remain in the rectal wall<sup>[28]</sup>. The risk of nodal metastasis in ypT0-1 is about 7%, compared to 30% for ypT2-4 (range 23%-37%). Read *et al.*<sup>[29]</sup> found 3.5% involvement in T0-1, 23% in T2 and 51.5% in T3-4. Zmora *et al.*<sup>[30]</sup> observed a higher incidence in T0-1, 12.1%. Park *et al.*<sup>[31]</sup> found similar data: ypT0 9.1%, ypT1 17.1%, ypT2 20.8%. In our series we found 9.4% nodal involvement in ypT0-1, 22.2% in ypT2 and 43.7% in ypT3-4. Therefore, the identification of predictive criteria related both the primary tumor and lymph nodes seems to be important to select patients for local surgery, because we must not forget that radical surgical resection with TME, gold standard to compare with other alternatives, is associated with very good oncologic outcomes. In line with our study, Berho *et al.*<sup>[32]</sup> found correlation between postoperative N stage and TRG, suggesting that neoadjuvant therapy should have a positive impact on overall survival. This study shows the low incidence of lymph node metastasis (14.2%) in good responders, findings similar to ours, where the percentage in TRG1 and 2 patients was 10.8%.

Our data confirms the association between the response to neoadjuvant therapy and lymph node involvement in RC<sup>[29,32,33]</sup>. Some studies have shown a relationship between good response to CRT and survival, suggesting that oncologic outcomes are more related to postoperative TNM stage, so TRG may be emerging as an independent prognostic factor<sup>[15,22,34]</sup>. The correlation with ypT stage strengthens this hypothesis. Dhadda *et al.*<sup>[35]</sup> ( $n = 158$ ) concluded that Mandard's scoring system is an independent prognostic factor predicting long-term outcomes. This index has already shown association with prognosis in esophageal cancer patients after CRT<sup>[11]</sup>. The authors propose its use in assessing the adjuvant therapy. Patients with TRG1-2 would be those with tumors sensitive to 5-FU therapy, while TRG3-5 or with positive nodes have worse prognosis and will require more intensive therapies.

The number of positive nodes is related not only with vascular invasion, but also with the reported number, which varies depending on factors related to



the patient (age, sex, body mass index), the tumor (size, stage, grade), and the experience of the surgeon and the pathologist<sup>[36]</sup>. In our series the average nodes retrieval in the surgical specimen was 9.4. Although the American Joint Committee on Cancer recommends a minimum of 12 nodes for a correct staging, the number of isolated nodes in RC without treatment ranges from 9 to 13 and in patients with neoadjuvant therapy is usually lower<sup>[37-39]</sup>, in part because of the depletion due to treatment and fibrosis, which makes the nodes smaller and more difficult to identify. The significance of this issue is unclear. Some authors consider it a marker of better response and is associated with a higher rate of pCR<sup>[26]</sup>. Marks *et al*<sup>[40]</sup> ( $n = 176$ ) found only 28% of patients treated with CRT followed by TME in which more than 12 lymph nodes were identified in the resected specimen. Similar data were observed in a study by Govindarajan *et al*<sup>[41]</sup> ( $n = 429$ ), where the average retrieved nodes was 10% and 63% of cases were under 12. In our series, only in 28.5% of cases more than 12 lymph nodes were identified. The inability to study more than 12 nodes is not associated to a worse prognosis in RC. Habr-Gama *et al*<sup>[42]</sup> showed that patients with no identifiable lymph nodes in the resected proctectomy specimens after CRT have excellent oncologic outcomes similar to those with ypN0 stage. Sprenger *et al*<sup>[43]</sup> have managed to increase, by intensive pathological examination, the number of identified lymph nodes and the incidence of N+, often with the presence of micrometastasis, although with no prognostic significance. Newer therapy strategies could have an impact in the near future<sup>[44]</sup>.

In conclusion, in our series the response to neoadjuvant CRT in locally advanced rectal cancer is correlated with lymph node involvement in the surgical specimens. TRG therefore could have clinical implications in the future in order to provide tailored therapies.

## ACKNOWLEDGMENTS

The authors would like to thank the members of the Hospital Universitario Central de Asturias Human Tissue Biobank for their technical support and Ángela García-González for the statistical review of the study.

## COMMENTS

### Background

Neoadjuvant therapy with chemoradiation (CRT) improves local control and reduces toxicity compared to postoperative therapies. CRT is superior in terms of local recurrence and acute toxicity. Around 60% of these patients experience some degree of tumor regression, but only a minor percentage will show pathologic complete response. The response of the primary tumor to neoadjuvant therapy, measured by tumor regression grading seems to be a good prognostic factor, nevertheless this relationship is controversial.

### Research frontiers

One of the most important prognostic factors is lymph node stage, but its relationship with the response to neoadjuvant therapy has not been studied extensively.

## Innovations and breakthroughs

This is a study to establish the relationship between lymph node involvement and the response to neoadjuvant CRT in locally advanced rectal cancer.

## Applications

In the series the response to neoadjuvant CRT in locally advanced rectal cancer is correlated with lymph node involvement in the surgical specimens. TRG therefore could have clinical implications in the future in order to provide tailored therapies.

## Terminology

T-downstaging, evidenced by TNM staging, is defined as the reduction of at least one T level measured initially by endorectal ultrasound and/or pelvic magnetic resonance imaging and finally by pathological evaluation. Pathologic complete response is defined as the absence of tumor cells in the surgical specimen.

## Peer-review

This work describes the efficacy of chemoradiation therapy in local advanced rectal cancer and concludes that lymph node metastasis is associated with the treatment failure. The writing is good and the conclusion is considerable.

## REFERENCES

- 1 Ferlay J, Shin HR, Bray F, Forman D, Mathers C, Parkin DM. GLOBO-CAN 2008, cancer incidence and mortality world-wide: IARC CancerBase No.10 (Internet). International Agency for Research on Cancer, Lyon, France, 2010. Available from: URL: <http://globocan.iarc.fr>
- 2 Sauer R, Becker H, Hohenberger W, Rödel C, Wittekind C, Fietkau R, Martus P, Tschmelitsch J, Hager E, Hess CF, Karstens JH, Liersch T, Schmidberger H, Raab R. Preoperative versus postoperative chemoradiotherapy for rectal cancer. *N Engl J Med* 2004; **351**: 1731-1740 [PMID: 15496622]
- 3 Kuremsky JG, Tepper JE, McLeod HL. Biomarkers for response to neoadjuvant chemoradiation for rectal cancer. *Int J Radiat Oncol Biol Phys* 2009; **74**: 673-688 [PMID: 19480968 DOI: 10.1016/j.ijrobp.2009.03.003]
- 4 Rödel C, Martus P, Papadopoulos T, Füzesi L, Klimpfinger M, Fietkau R, Liersch T, Hohenberger W, Raab R, Sauer R, Wittekind C. Prognostic significance of tumor regression after preoperative chemoradiotherapy for rectal cancer. *J Clin Oncol* 2005; **23**: 8688-8696 [PMID: 16246976]
- 5 Drebber U, Madeja M, Odenthal M, Wedemeyer I, Mönig SP, Brabender J, Bollschweiler E, Hölscher AH, Schneider PM, Dienes HP, Vallböhmer D.  $\beta$ -catenin and Her2/neu expression in rectal cancer: association with histomorphological response to neoadjuvant therapy and prognosis. *Int J Colorectal Dis* 2011; **26**: 1127-1134 [PMID: 21538055 DOI: 10.1007/s00384-011-1213-9]
- 6 Jakob C, Liersch T, Meyer W, Baretton GB, Schwabe W, Häusler P, Kulle B, Becker H, Aust DE. Prognostic value of histologic tumor regression, thymidylate synthase, thymidine phosphorylase, and dihydropyrimidine dehydrogenase in rectal cancer UICC Stage II/III after neoadjuvant chemoradiotherapy. *Am J Surg Pathol* 2006; **30**: 1169-1174 [PMID: 16931962]
- 7 Beddy D, Hyland JM, Winter DC, Lim C, White A, Moriarty M, Armstrong J, Fennelly D, Gibbons D, Sheahan K. A simplified tumor regression grade correlates with survival in locally advanced rectal carcinoma treated with neoadjuvant chemoradiotherapy. *Ann Surg Oncol* 2008; **15**: 3471-3477 [PMID: 18846402 DOI: 10.1245/s10434-008-0149-y]
- 8 Rosenberg R, Nekarda H, Zimmermann F, Becker K, Lordick F, Hofler H, Molls M, Siewert JR. Histopathological response after preoperative radiochemotherapy in rectal carcinoma is associated with improved overall survival. *J Surg Oncol* 2008; **97**: 8-13 [PMID: 18085619]
- 9 Colombo PE, Patani N, Bibeau F, Assenat E, Bertrand MM, Senesse P, Rouanet P. Clinical impact of lymph node status in

- rectal cancer. *Surg Oncol* 2011; **20**: e227-e233 [PMID: 21911287 DOI: 10.1016/j.suronc.2011.08.004]
- 10 **Sobin LH**, Wittekin Ch. International Union Against Cancer (UICC) TNM classification of malignant tumors, 6th edn. Wiley-Liss, New York, 2002
  - 11 **Mandard AM**, Dalibard F, Mandard JC, Marnay J, Henry-Amar M, Petiot JF, Roussel A, Jacob JH, Segol P, Samama G. Pathologic assessment of tumor regression after preoperative chemoradiotherapy of esophageal carcinoma. Clinicopathologic correlations. *Cancer* 1994; **73**: 2680-2686 [PMID: 8194005]
  - 12 **Taylor FG**, Quirke P, Heald RJ, Moran B, Blomqvist L, Swift I, Sebag-Montefiore DJ, Tekkis P, Brown G. Preoperative high-resolution magnetic resonance imaging can identify good prognosis stage I, II, and III rectal cancer best managed by surgery alone: a prospective, multicenter, European study. *Ann Surg* 2011; **253**: 711-719 [PMID: 21475011 DOI: 10.1097/SLA.0b013e31820b8d52]
  - 13 **Weiser MR**, Fichera A, Schrag D, Boughey JC, You YN. Progress in the PROSPECT trial: precision treatment for rectal cancer? *Bull Am Coll Surg* 2015; **100**: 51-52 [PMID: 25939207]
  - 14 **Ptok H**, Meyer F, Steinert R, Vieth M, Ridwelski K, Lippert H, Gastinger I. No prognostic impact of isolated lymphovascular invasion after radical resection of rectal cancer--results of a multicenter observational study. *Int J Colorectal Dis* 2007; **22**: 749-756 [PMID: 17123090]
  - 15 **Losi L**, Luppi G, Gavioli M, Iachetta F, Bertolini F, D'Amico R, Jovic G, Bertoni F, Falchi AM, Conte PF. Prognostic value of Dworak grade of regression (GR) in patients with rectal carcinoma treated with preoperative radiochemotherapy. *Int J Colorectal Dis* 2006; **21**: 645-651 [PMID: 16317549]
  - 16 **Moreno García V**, Cejas P, Blanco Codesido M, Feliu Batlle J, de Castro Carpeño J, Belda-Iniesta C, Barriuso J, Sánchez JJ, Larrauri J, González-Barón M, Casado E. Prognostic value of carcinoembryonic antigen level in rectal cancer treated with neoadjuvant chemoradiotherapy. *Int J Colorectal Dis* 2009; **24**: 741-748 [PMID: 19259690 DOI: 10.1007/s00384-009-0682-6]
  - 17 **Suárez J**, Vera R, Balén E, Gómez M, Arias F, Lera JM, Herrera J, Zazpe C. Pathologic response assessed by Mandard grade is a better prognostic factor than down staging for disease-free survival after preoperative radiochemotherapy for advanced rectal cancer. *Colorectal Dis* 2008; **10**: 563-568 [PMID: 18070184]
  - 18 **Tsujinaka S**, Kawamura YJ, Konishi F, Aihara H, Maeda T, Mizokami K. Long-term efficacy of preoperative radiotherapy for locally advanced low rectal cancer. *Int J Colorectal Dis* 2008; **23**: 67-76 [PMID: 17704925]
  - 19 **Bosset JF**, Collette L, Calais G, Mineur L, Maingon P, Radosevic-Jelic L, Daban A, Bardet E, Beny A, Ollier JC. Chemotherapy with preoperative radiotherapy in rectal cancer. *N Engl J Med* 2006; **355**: 1114-1123 [PMID: 16971718]
  - 20 **García-Aguilar J**, Hernandez de Anda E, Sirivongs P, Lee SH, Madoff RD, Rothenberger DA. A pathologic complete response to preoperative chemoradiation is associated with lower local recurrence and improved survival in rectal cancer patients treated by mesorectal excision. *Dis Colon Rectum* 2003; **46**: 298-304 [PMID: 12626903]
  - 21 **Habr-Gama A**, Perez RO, Nadalin W, Nahas SC, Ribeiro U, Silva E Sousa AH, Campos FG, Kiss DR, Gama-Rodrigues J. Long-term results of preoperative chemoradiation for distal rectal cancer correlation between final stage and survival. *J Gastrointest Surg* 2005; **9**: 90-99; discussion 99-101 [PMID: 15623449]
  - 22 **Vecchio FM**, Valentini V, Minsky BD, Padula GD, Venkatraman ES, Balducci M, Miccichi F, Ricci R, Morganti AG, Gambacorta MA, Maurizi F, Coco C. The relationship of pathologic tumor regression grade (TRG) and outcomes after preoperative therapy in rectal cancer. *Int J Radiat Oncol Biol Phys* 2005; **62**: 752-760 [PMID: 15936556]
  - 23 **Capirci C**, Valentini V, Cionini L, De Paoli A, Rodel C, Glynn-Jones R, Coco C, Romano M, Mantello G, Palazzi S, Mattia FO, Friso ML, Genovesi D, Vidali C, Gambacorta MA, Buffoli A, Lupattelli M, Favretto MS, La Torre G. Prognostic value of pathologic complete response after neoadjuvant therapy in locally advanced rectal cancer: long-term analysis of 566 ypCR patients. *Int J Radiat Oncol Biol Phys* 2008; **72**: 99-107 [PMID: 18407433 DOI: 10.1016/j.ijrobp.2007.12.019]
  - 24 **Tytherleigh MG**, Ng VV, Pittathankal AA, Wilson MJ, Farouk R. Preoperative staging of rectal cancer by magnetic resonance imaging remains an imprecise tool. *ANZ J Surg* 2008; **78**: 194-198 [PMID: 18269488 DOI: 10.1111/j.1445-2197.2007.04402.x]
  - 25 **Huh JW**, Park YA, Jung EJ, Lee KY, Sohn SK. Accuracy of endorectal ultrasonography and computed tomography for restaging rectal cancer after preoperative chemoradiation. *J Am Coll Surg* 2008; **207**: 7-12 [PMID: 18589355 DOI: 10.1016/j.jamcollsurg.2008.01.002]
  - 26 **Duldulao MP**, Lee W, Streja L, Chu P, Li W, Chen Z, Kim J, Garcia-Aguilar J. Distribution of residual cancer cells in the bowel wall after neoadjuvant chemoradiation in patients with rectal cancer. *Dis Colon Rectum* 2013; **56**: 142-149 [PMID: 23303141 DOI: 10.1097/DCR.0b013e31827541e2]
  - 27 **Hiotis SP**, Weber SM, Cohen AM, Minsky BD, Paty PB, Guillem JG, Wagman R, Saltz LB, Wong WD. Assessing the predictive value of clinical complete response to neoadjuvant therapy for rectal cancer: an analysis of 488 patients. *J Am Coll Surg* 2002; **194**: 131-135; discussion 135-136; [PMID: 11848629]
  - 28 **Mignanelli ED**, de Campos-Lobato LF, Stocchi L, Lavery IC, Dietz DW. Downstaging after chemoradiotherapy for locally advanced rectal cancer: is there more (tumor) than meets the eye? *Dis Colon Rectum* 2010; **53**: 251-256 [PMID: 20173469 DOI: 10.1007/DCR.0b013e3181bcd3cc]
  - 29 **Read TE**, Andujar JE, Caushaj PF, Johnston DR, Dietz DW, Myerson RJ, Fleshman JW, Birnbaum EH, Mutch MG, Kodner IJ. Neoadjuvant therapy for rectal cancer: histologic response of the primary tumor predicts nodal status. *Dis Colon Rectum* 2004; **47**: 825-831 [PMID: 15108025]
  - 30 **Zmora O**, Dasilva GM, Gurland B, Pfeffer R, Koller M, Nogueras JJ, Wexner SD. Does rectal wall tumor eradication with preoperative chemoradiation permit a change in the operative strategy? *Dis Colon Rectum* 2004; **47**: 1607-1612 [PMID: 15540288]
  - 31 **Park IJ**, You YN, Skibber JM, Rodriguez-Bigas MA, Feig B, Nguyen S, Hu CY, Chang GJ. Comparative analysis of lymph node metastases in patients with ypT0-2 rectal cancers after neoadjuvant chemoradiotherapy. *Dis Colon Rectum* 2013; **56**: 135-141 [PMID: 23303140 DOI: 10.1097/DCR.0b013e318278ff8a]
  - 32 **Berho M**, Oviedo M, Stone E, Chen C, Nogueras J, Weiss E, Sands D, Wexner S. The correlation between tumour regression grade and lymph node status after chemoradiation in rectal cancer. *Colorectal Dis* 2009; **11**: 254-258 [PMID: 18513188 DOI: 10.1111/j.1463-1318.2008.01597.x]
  - 33 **Elezkurtaj S**, Moser L, Budczie J, Müller AJ, Bläker H, Buhr HJ, Dietel M, Kruschewski M. Histopathological regression grading matches excellently with local and regional spread after neoadjuvant therapy of rectal cancer. *Pathol Res Pract* 2013; **209**: 424-428 [PMID: 23706942 DOI: 10.1016/j.prp.2013.04.009]
  - 34 **Bouzourene H**, Bosman FT, Seelentag W, Matter M, Coucke P. Importance of tumor regression assessment in predicting the outcome in patients with locally advanced rectal carcinoma who are treated with preoperative radiotherapy. *Cancer* 2002; **94**: 1121-1130 [PMID: 11920483]
  - 35 **Dhadda AS**, Dickinson P, Zaitoun AM, Gandhi N, Bessell EM. Prognostic importance of Mandard tumour regression grade following pre-operative chemo/radiotherapy for locally advanced rectal cancer. *Eur J Cancer* 2011; **47**: 1138-1145 [PMID: 21220198 DOI: 10.1016/j.ejca.2010.12.006]
  - 36 **Chang GJ**, Rodriguez-Bigas MA, Skibber JM, Moyer VA. Lymph node evaluation and survival after curative resection of colon cancer: systematic review. *J Natl Cancer Inst* 2007; **99**: 433-441 [PMID: 17374833]
  - 37 **Beresford M**, Glynn-Jones R, Richman P, Makris A, Mawdsley S, Stott D, Harrison M, Osborne M, Ashford R, Grainger J, Al-Jabbour J, Talbot I, Mitchell IC, Meyrick Thomas J, Livingstone JJ, McCue J, MacDonald P, Northover JA, Windsor A, Novell R, Wallace M, Harrison RA. The reliability of lymph-node staging in rectal cancer after preoperative chemoradiotherapy. *Clin Oncol (R*

- Coll Radiol) 2005; **17**: 448-455 [PMID: 16149289]
- 38 **Wichmann MW**, Müller C, Meyer G, Strauss T, Hornung HM, Lau-Werner U, Angele MK, Schildberg FW. Effect of preoperative radiochemotherapy on lymph node retrieval after resection of rectal cancer. *Arch Surg* 2002; **137**: 206-210 [PMID: 11822961]
- 39 **de Campos-Lobato LF**, Stocchi L, de Sousa JB, Buta M, Lavery IC, Fazio VW, Dietz DW, Kalady MF. Less than 12 nodes in the surgical specimen after total mesorectal excision following neoadjuvant chemoradiation: it means more than you think! *Ann Surg Oncol* 2013; **20**: 3398-3406 [PMID: 23812804 DOI: 10.1245/s10434-013-3010-x]
- 40 **Marks JH**, Valsdottir EB, Rather AA, Nweze IC, Newman DA, Chernick MR. Fewer than 12 lymph nodes can be expected in a surgical specimen after high-dose chemoradiation therapy for rectal cancer. *Dis Colon Rectum* 2010; **53**: 1023-1029 [PMID: 20551754 DOI: 10.1007/DCR.0b013e3181d4deb4]
- 41 **Govindarajan A**, Gönen M, Weiser MR, Shia J, Temple LK, Guillem JG, Paty PB, Nash GM. Challenging the feasibility and clinical significance of current guidelines on lymph node examination in rectal cancer in the era of neoadjuvant therapy. *J Clin Oncol* 2011; **29**: 4568-4573 [PMID: 21990400 DOI: 10.1200/JCO.2011.37.2235]
- 42 **Habr-Gama A**, Perez RO, Proscurshim I, Rawet V, Pereira DD, Sousa AH, Kiss D, Ceconello I. Absence of lymph nodes in the resected specimen after radical surgery for distal rectal cancer and neoadjuvant chemoradiation therapy: what does it mean? *Dis Colon Rectum* 2008; **51**: 277-283 [PMID: 18183463 DOI: 10.1007/s10350-007-9148-5]
- 43 **Sprenger T**, Rothe H, Becker H, Beissbarth T, Homayounfar K, Gauss K, Kitz J, Wolff H, Scheel AH, Ghadimi M, Rödel C, Conradi LC, Liersch T. Lymph node metastases in rectal cancer after preoperative radiochemotherapy: impact of intramesorectal distribution and residual micrometastatic involvement. *Am J Surg Pathol* 2013; **37**: 1283-1289 [PMID: 23851331 DOI: 10.1097/PAS.0b013e3182886ced]
- 44 **Pettersson D**, Lörinc E, Holm T, Iversen H, Cedermark B, Glimelius B, Martling A. Tumour regression in the randomized Stockholm III Trial of radiotherapy regimens for rectal cancer. *Br J Surg* 2015; **102**: 972-978; discussion 978 [PMID: 26095256 DOI: 10.1002/bjs.9811]

**P- Reviewer:** Albulescu R, Hsu CP

**S- Editor:** Ji FF **L- Editor:** A **E- Editor:** Li D



## Case Control Study

## Validation of a new scoring system: Rapid assessment faecal incontinence score

Fernando de la Portilla, Arantxa Calero-Lillo, Rosa M Jiménez-Rodríguez, Maria L Reyes, Manuela Segovia-González, María Victoria Maestre, Ana M García-Cabrera

Fernando de la Portilla, Centro de Investigación Biomédica en Red de Enfermedades Hepáticas y Digestivas (CIBEREHD o Ciberehd), Instituto de Salud Carlos III, 08036 Barcelona, Spain

Fernando de la Portilla, Arantxa Calero-Lillo, Rosa M Jiménez-Rodríguez, Maria L Reyes, María Victoria Maestre, Ana M García-Cabrera, Department of General and Digestive Surgery, Colorectal Surgery Unit, "Virgen del Rocío" University Hospital/IBiS/CSIC/University of Seville, 41013 Seville, Spain

Manuela Segovia-González, Department of Economics, Quantitative Methods, University Pablo Olavide of Seville, 41013 Seville, Spain

**Author contributions:** de la Portilla F was responsible for the conception and design of the study, he acquired, analyzed and interpreted the data and drafted the manuscript and was responsible for revising the manuscript critically for important intellectual content; Calero-Lillo A, Jiménez-Rodríguez RM, Reyes ML, Segovia-González M and García-Cabrera AM contributed to the establishment of the methods and the development of the study.

**Institutional review board statement:** This study was approved by the Institutional Review Board of our hospital.

**Informed consent statement:** All patients gave their informed consent to take part in the study.

**Conflict-of-interest statement:** Drs. Fernando de la Portilla, Rosa M Jiménez-Rodríguez, Ana M García-Cabrera, Maria L Reyes and Manuela Segovia-González have no conflicts of interest or financial ties to disclose. Dr. Calero-Lillo received a grant from the Spanish Association of Coloproctology (Asociación Española de Coloproctología - AECP) to do research for a period of 3 mo at our institution, the University Hospital Virgen del Rocío in Seville.

**Data sharing statement:** Technical appendix, statistical code, and dataset available from the corresponding author at [fportilla@us.es](mailto:fportilla@us.es). Participants gave informed consent for data sharing. No additional data are available.

**Open-Access:** This article is an open-access article which was

selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Correspondence to:** Fernando de la Portilla, MD, PhD, EBSQ-C, MAECP, Department of General and Digestive Surgery, Colorectal Surgery Unit, "Virgen del Rocío" University Hospital/IBiS/CSIC/University of Seville, Avda. Manuel Siurot s/n, 41013 Seville, Spain. [fportilla@us.es](mailto:fportilla@us.es)  
**Telephone:** +34-95-5012292  
**Fax:** +34-95-5012292

**Received:** March 26, 2015  
**Peer-review started:** March 28, 2015  
**First decision:** May 13, 2015  
**Revised:** June 6, 2015  
**Accepted:** July 16, 2015  
**Article in press:** July 17, 2015  
**Published online:** September 27, 2015

### Abstract

**AIM:** To implement a quick and simple test - rapid assessment faecal incontinence score (RAFIS) and show its reliability and validity.

**METHODS:** From March 2008 through March 2010, we evaluated a total of 261 consecutive patients, including 53 patients with faecal incontinence. Demographic and comorbidity information was collected. In a single visit, patients were administered the RAFIS. The results obtained with the new score were compared with those of both Wexner score and faecal incontinence quality of life scale (FIQL) questionnaire. The patient without



influence of the surgeon completed the test. The role of surgeon was explaining the meaning of each section and how he had to fill. Reliability of the RAFIS score was measured using intra-observer agreement and Cronbach's alpha (internal consistency) coefficient. Multivariate analysis of the main components within the different scores was performed in order to determine whether all the scores measured the same factor and to conclude whether the information could be encompassed in a single factor. A sample size of 50 patients with faecal incontinence was estimated to be enough to detect a correlation of 0.55 or better at 5% level of significance with 80% power.

**RESULTS:** We analysed the results obtained by 53 consecutive patients with faecal incontinence (median age  $61.55 \pm 12.49$  years) in the three scoring systems. A total of 208 healthy volunteers (median age  $58.41 \pm 18.41$  years) without faecal incontinence were included in the study as negative controls. Pearson's correlation coefficient between "state" and "leaks" was excellent ( $r = 0.92$ ,  $P < 0.005$ ). Internal consistency in the comparison of "state" and "leaks" yielded also excellent correlation (Cronbach's  $\alpha = 0.93$ ). Results in each score were compared using regression analysis and a correlation value of  $r = 0.98$  was obtained with Wexner score. As regards FIQL questionnaire, the values of " $r$ " for the different subscales of the questionnaire were: "lifestyle"  $r = -0.87$ , "coping/behaviour"  $r = -0.91$ , "depression"  $r = -0.36$  and "embarrassment"  $r = -0.90$ , ( $P < 0.01$ ). A multivariate analysis showed that all the scoring systems measured the same factor. A single factor may explain 80.84% of the variability of FI, so all the scoring systems measure the same factor. Patient's continence improves when RAFIS and Jorge-Wexner scores show low values and when the values obtained in the FIQL questionnaire are high.

**CONCLUSION:** RAFIS is a valid and reliable tool to assess Faecal Incontinence.

**Key words:** Faecal incontinence; Measure; Score; Test; Faecal incontinence quality of life scale questionnaire

© The Author(s) 2015. Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** There are different scales for measuring the severity and impact of faecal incontinence (FI), but no together. The authors recommend the combined use of them to get a complete evaluation of FI. The aim of the present study is to implement a quick and simple test to assess faecal incontinence - the rapid assessment faecal incontinence score - and show its reliability and validity. Its validity and reliability has been proved when compared with other widely used scores.

de la Portilla F, Calero-Lillo A, Jiménez-Rodríguez RM, Reyes ML, Segovia-González M, Maestre MV, García-Cabrera AM. Validation of a new scoring system: Rapid

assessment faecal incontinence score. *World J Gastrointest Surg* 2015; 7(9): 203-207 Available from: URL: <http://www.wjgnet.com/1948-9366/full/v7/i9/203.htm> DOI: <http://dx.doi.org/10.4240/wjgs.v7.i9.203>

## INTRODUCTION

Faecal incontinence (FI) refers to the inability to control gas, liquid or solid stool passage<sup>[1]</sup>. FI has a high prevalence in our environment, affecting 10% of primary care patients and having a significant impact on mental health<sup>[2]</sup>. The cause of FI can be stool characteristics, rectal or sphincter dysfunctions or neurological disorders<sup>[3]</sup>.

The assessment of FI should be performed in a simple way but it must take into account two different factors which may be associated, that is, FI severity and impact of FI on quality of life of patients. As a result, its assessment may be difficult.

Severity refers to the number and characteristics of leaks and it can be measured using nominal scales, which is less frequent or by means of ordinal scales. The latter assign a numeric value to FI and are nowadays the preferred assessment method<sup>[4-7]</sup>. One of the most widely used scales is the Jorge-Wexner score (the wexner cleveland clinic florida score)<sup>[3]</sup>.

The impact of FI on patient's quality of life can be measured using generic scales such as the SF36 questionnaire. Visual analogue scales for grading FI have been employed as well<sup>[8]</sup>. Widely used is the rockwood faecal incontinence quality of life scale (FIQL)<sup>[9]</sup> which contains a total of 29 different items assessing social, emotional, occupational and functional aspects. This scale has been translated and validated into Spanish<sup>[10]</sup>.

Although severity scales have progressively included items which try to measure "impact", the impact FI has on patients is more thoroughly assessed using its own specific scales. Some authors even recommend the use of a combination of two different scoring systems for severity and impact on quality of life respectively in order to attain a complete evaluation of FI<sup>[11]</sup>.

The objective of this study is to implement a new score that allows the joint measurement of severity and impact in a simple way. Reliability and validity have been analysed comparing the new score with the Jorge-Wexner score and FIQL questionnaire.

## MATERIALS AND METHODS

From March 2008 through March 2010, we evaluated a total of 261 consecutive patients (145 females, median age  $59.05 \pm 17.39$  years) from the Proctology clinic. Demographic and comorbidity information was collected. In a single visit, patients were administered the Rapid Assessment Faecal Incontinence Score (RAFIS) (Figure 1), and the Jorge-Wexner score. The patient without influence of the surgeon completed the

According to the number of leaks I feel



You are very bad	You are bad	You are regular	You are well	You are very well	You are excellent
10	8	6	4	2	0

Note down the frequency of leaks (you can only tick one)

Several leaks daily	10	
Several leaks weekly but not daily	8	
Several leaks monthly but there is a week without leaks	6	
Leaks from time to time, but there is a full month without leaks	4	
Leaks occur rarely	2	
No leaks	0	

Figure 1 Rapid assessment faecal incontinence score.

Table 1 Demographic data and results of the different scores

	Incontinent patients	Control patients
Number of patients	53	208
Age (mean $\pm$ SD)	61.55 $\pm$ 12.49	58.41 $\pm$ 18.41
RAFIS state (mean $\pm$ SD)	6.91 $\pm$ 2.37	0
RAFIS leaks (mean $\pm$ SD)	7.25 $\pm$ 2.48	0
RAFIS global (mean $\pm$ SD)	14.15 $\pm$ 4.09	0
Jorge-wexner score (mean $\pm$ SD)	13.32 $\pm$ 4.95	0
FIQL test lifestyle (mean $\pm$ SD)	2.99 $\pm$ 0.96	4.99 $\pm$ 0.06
FIQL test coping/behaviour (mean $\pm$ SD)	2.48 $\pm$ 0.95	4.99 $\pm$ 0.06
FIQL test depression (mean $\pm$ SD)	3.23 $\pm$ 1.63	4.20 $\pm$ 0.84
FIQL test embarrassment (mean $\pm$ SD)	2.59 $\pm$ 0.95	5 $\pm$ 0

RAFIS: Rapid assessment faecal incontinence score; FIQL: Faecal incontinence quality of life scale.

test. The role of surgeon was explaining the meaning of each section and how he had to fill.

The score is composed of two sections: (1) Visual-descriptive ordinal trying to define in concrete terms how it affects the patient fecal incontinence; and (2) the frequency of episodes, which generally describes many episodes of incontinences have the patient in a month.

RAFIS total score was obtained after each patient made a selection in our score according to the frequency and number of leaks.

A sample size of 50 patients with faecal incontinence was estimated to be enough to detect a correlation of 0.55 or better at 5% level of significance with 80% power.

Reliability of the RAFIS score was measured using intra-observer agreement and Cronbach's alpha (internal consistency) coefficient. In both cases, the items "State" and "Leaks" were compared. A value  $\geq 0.7$  is acceptable in the case of intra-observer agreement. As for Cronbach's alpha, an internal consistency value of  $\alpha \geq 0.7$  is acceptable and a value of  $\alpha > 0.9$  is excellent.

Validity of RAFIS score was assessed by means of convergent validity. RAFIS was compared with Jorge-Wexner score and with FIQL questionnaire. Also, a

Table 2 External validity of the score compared with Jorge-Wexner score and faecal incontinence quality of life scale questionnaire

	Correlation
RAFIS global - Jorge-Wexner score	0.98 <sup>b</sup>
RAFIS global - FIQL test lifestyle	- 0.87 <sup>b</sup>
RAFIS global - FIQL test coping/behaviour	- 0.91 <sup>b</sup>
RAFIS global - FIQL test depression	-0.36 <sup>b</sup>
RAFIS global - FIQL test embarrassment	-0.90 <sup>b</sup>

<sup>b</sup>Significance at 1% ( $P < 0.01$ ). RAFIS: Rapid assessment faecal incontinence score; FIQL: Faecal incontinence quality of life scale.

multivariate analysis of the main components within the different scores was performed in order to determine whether all the scores measured the same factor and to conclude whether the information could be encompassed in a single factor.

The statistical analysis was performed using SPSS 20.0 software and a value of  $P < 0.05$  was considered significant.

Since no intervention was performed on patients, approval by the Ethics Committee was not necessary.

## RESULTS

We analysed the results obtained by 53 consecutive patients with faecal incontinence (median age 61.55  $\pm$  12.49 years) in the three scoring systems. A total of 208 healthy volunteers (median age 58.41  $\pm$  18.41 years) without faecal incontinence were included in the study as negative controls. Age below 18 was an exclusion criteria. Table 1 shows demographic data and the results obtained in the scores.

RAFIS reliability was measured using intra-observer agreement. Pearson's correlation coefficient between "state" and "leaks" was excellent ( $r = 0.92$ ,  $P < 0.005$ ). Internal consistency in the comparison of "state" and "leaks" yielded also excellent correlation (Cronbach's  $\alpha = 0.93$ ).

Validity assessment of the new score yielded a high correlation with both Jorge-Wexner score and with the different subscales of FIQL, as shown in Table 2.

In order to complete the study, a multivariate analysis was also carried out of the global results obtained in the different scoring systems (Jorge-Wexner, FIQL lifestyle, coping/behaviour, depression and embarrassment) and RAFIS. A single factor may explain 80.84% of the variability of FI, so all the scoring systems measure the same factor. Patient's continence improves when RAFIS and Jorge-Wexner scores show low values and when the values obtained in the FIQL questionnaire are high (Table 3).

## DISCUSSION

RAFIS comprises two items: State and leaks. The former is measured by means of a visual analogue scale and the latter by means of an ordinary scale.

**Table 3** Multivariate analysis

RAFIS global	0.96
Jorge-Wexner score	0.96
FIQL test lifestyle	-0.95
FIQL test coping/behaviour	-0.97
FIQL test depression	-0.47
FIQL test embarrassment	-0.97

RAFIS: Rapid assessment faecal incontinence score; FIQL: Faecal incontinence quality of life scale.

Visual analogue scales were chosen as measurement tool because they have a high correlation with reality and are easy to understand by patients. Moreover, the advantages of visual analogue scales of faces are well established<sup>[12]</sup>.

In our study, the measurement of leaks introduces a novel simplification as it does not consider the quality of faecal leaks but only their frequency. We do not take into account such variables as pad usage (evaluated in Jorge-Wexner score or Vaizey test<sup>[6]</sup>), the necessity to change underwear (included in RFIS test<sup>[7]</sup>), faecal urgency or anti-diarrheal drugs (measured in Vaizey test).

In our country, Devesa *et al.*<sup>[8]</sup> have used numeric visual analogue scales to assess the severity of FI and its impact on quality of life of patients. They found no correlation between visual analogue scales for FI and Jorge-Wexner score but they observed a significant correlation with the "embarrassment" subscale of FIQL. They also found correlation between visual analogue scales for quality of life and the "coping/behaviour" subscale of FIQL. Our study shows a significant correlation between RAFIS global and Jorge-Wexner score.

The impact of FI on quality of life has long been discussed and several studies have established the importance of such impact. Minguez *et al.*<sup>[10]</sup> validated the FIQL into Spanish and compared it with the Jorge-Wexner score. These authors observed a strong correlation among all the items. Their study also showed that pad usage is an independent factor which worsened quality of life scores. Similar results have been reported by Bols *et al.*<sup>[11]</sup> when they compared Jorge-Wexner score and Vaizey score with FIQL. They found a strong correlation between results, particularly in "embarrassment" and "coping/behaviour" subscales.

However, there are some studies which do not agree with these results. For instance, Borgeianou *et al.*<sup>[13]</sup> in their analysis of the correlation between faecal incontinence severity index and every one of the subscales in FIQL, found moderate correlations with embarrassment and coping/behaviour but no correlation at all with lifestyle and depression.

Another study by Damon *et al.*<sup>[14]</sup>, comparing Jorge-Wexner score with gastrointestinal quality of life index questionnaire, found a poor correlation between FI severity and quality of life.

Our study shows significant correlation between RAFIS and every subscale of FIQL with the exception of "depression" although higher depression scores as well as prior hysterectomy have moderate to severe quality of life impairment. Some authors said when evaluating FI, screening for mood disturbances should be undertaken<sup>[15]</sup>; however depression is multifactorial, in fact biological and environmental factors may be involved. This explains why scales depression associated with FI only have a lower correlation, without implication to determine the complete evaluation of FI.

In our opinion, the election of aggressive therapy for the treatment of FI should consider not only severity of symptoms but also impact on the quality of life of patients.

Our study has some limitations. In order to assess the reliability of our score, we compared two factors: Leaks and state. We obtained a high correlation. However, the best statistical tool is the Test-Retest, as has been proven by similar studies<sup>[16]</sup>. The same measurement is performed repeatedly at short intervals, which does not allow patients to change their status. Unfortunately, logistical reasons made it impossible to perform the test-retest. In spite of it, our score shows high reliability. Also, we could not demonstrate the sensitivity of our score to change after faecal incontinence therapy as our objective was to evaluate our new test to assess FI, so the test was not repeated after faecal incontinence therapy.

In our opinion RAFIS could be improved taking into account the factor of faecal urgency and a third section that refers to the type of incontinence (hard, liquid or gas feces). Urgency item was not taken into account due to the chosen gold standard scale for severity was Jorge-Wexner score, which does not include it, instead of Vaizey<sup>[6]</sup>. Vaizey score determines faecal urgency asking patients the ability to defer defecation for 15 min. We suggest asking about the need to stop the current activity in order to go to the toilet.

Bols *et al.*<sup>[11]</sup> compared Jorge-Wexner, Vaizey and FIQL scores, and Vaizey score showed that items "medication use," "pads," and "flatus incontinence" had poor external responsiveness, whereas "urgency" had adequate external responsiveness. The item "pad use" of the Wexner score also had poor external responsiveness.

Although RAFIS seems a valid and reliable scoring system in our environment, which could even replace Jorge-Wexner score and FIQL questionnaire, we still believe it is highly advisable to use a diary system as it provides an objective measurement of FI if correctly filled out by patients.

In our opinion RAFIS could be improved taking into account the factor of faecal urgency.

Faecal incontinence severity comprises two factors: objective (severity/leaks) and subjective (impact on quality of life/state). A new quick and simple score to assess FI has been tested showing its validity and reliability when compared with other widely used scores.

## ACKNOWLEDGMENTS

CIBERehd was funded by the Instituto de Salud Carlo III.

## COMMENTS

### Background

Several questionnaires have been used in different studies to evaluate fecal incontinence and how patient's life is disturbed by the symptoms. There are different scales for measuring the severity and impact of faecal incontinence (FI), but no together and a simple and quick score.

### Research frontiers

Creating a faecal incontinence scoring system which is both reproducible and simple to use is complex due to the variable nature of the condition.

### Innovations and breakthroughs

There are different scales for measuring the severity and impact of FI, but no together. The authors recommend the combined use of them to get a complete evaluation of FI. The aim of the present study is to implement a quick and simple test to assess FI - the rapid assessment faecal incontinence score - and show its reliability and validity. Its validity and reliability has been proved when compared with other widely used scores. The research fulfills the criteria of novelty and innovative because it proposes and shows a new and reliable way to measure faecal incontinence.

### Applications

Clinical assessment of severity of faecal incontinence varies between clinicians according to their expertise. This causes difficulties when comparing results of published data, often making comparisons of treatment modalities meaningless. Many attempts have been made in the past to develop scoring systems but their clinical applicability has not been validated adequately. This study has established the validity of a quick and simple test to assess FI, and it could also help select patients who could benefit from a affective treatment.

### Peer-review

The research is important, because it proposes a method of inquiring that could facilitate the communication between physicians and faecal incontinence patients. This new approach could have a positive impact on these patients treatment. Regarding the significance of the study findings, the authors showed excellent agreement and consistency for both criteria analyzed.

## REFERENCES

- 1 **Baxter NN**, Rothenberger DA, Lowry AC. Measuring fecal incontinence. *Dis Colon Rectum* 2003; **46**: 1591-1605 [PMID: 14668583 DOI: 10.1007/BF02660762]
- 2 **Parés D**, Vial M, Bohle B, Maestre Y, Pera M, Roura M, Comas M, Sala M, Grande L. Prevalence of faecal incontinence and analysis of its impact on quality of life and mental health. *Colorectal Dis* 2011; **13**: 899-905 [PMID: 20394640 DOI: 10.1111/j.1463-1318.2010.02281.x]
- 3 **Jorge JM**, Wexner SD. Etiology and management of fecal incontinence. *Dis Colon Rectum* 1993; **36**: 77-97 [PMID: 8416784 DOI: 10.1007/BF02050307]
- 4 **Pescatori M**, Anastasio G, Bottini C, Mentasti A. New grading and scoring for anal incontinence. Evaluation of 335 patients. *Dis Colon Rectum* 1992; **35**: 482-487 [PMID: 1568401 DOI: 10.1007/BF02049407]
- 5 **Rockwood TH**, Church JM, Fleshman JW, Kane RL, Mavrantonis C, Thorson AG, Wexner SD, Bliss D, Lowry AC. Patient and surgeon ranking of the severity of symptoms associated with fecal incontinence: the fecal incontinence severity index. *Dis Colon Rectum* 1999; **42**: 1525-1532 [PMID: 10613469 DOI: 10.1007/BF02236199]
- 6 **Vaizey CJ**, Carapeti E, Cahill JA, Kamm MA. Prospective comparison of faecal incontinence grading systems. *Gut* 1999; **44**: 77-80 [PMID: 9862829 DOI: 10.1136/gut.44.1.77]
- 7 **Sanson J**, Hawthorne G, Fleming G, Marosszeky N. The revised faecal incontinence scale: a clinical validation of a new, short measure for assessment and outcomes evaluation. *Dis Colon Rectum* 2013; **56**: 652-659 [PMID: 23575406 DOI: 10.1097/DCR.0b013e318279c2ac]
- 8 **Devesa JM**, Vicente R, Abreira V. Visual analogue scales for grading faecal incontinence and quality of life: their relationship with the Jorge-Wexner score and Rockwood scale. *Tech Coloproctol* 2013; **17**: 67-71 [PMID: 22936592 DOI: 10.1007/s10151-012-0884-8]
- 9 **Rockwood TH**, Church JM, Fleshman JW, Kane RL, Mavrantonis C, Thorson AG, Wexner SD, Bliss D, Lowry AC. Fecal Incontinence Quality of Life Scale: quality of life instrument for patients with fecal incontinence. *Dis Colon Rectum* 2000; **43**: 9-16; discussion 16-17 [PMID: 10813117 DOI: 10.1007/BF02237236]
- 10 **Minguez M**, Garrigues V, Soria MJ, Andreu M, Mearin F, Clave P. Adaptation to Spanish language and validation of the fecal incontinence quality of life scale. *Dis Colon Rectum* 2006; **49**: 490-499 [PMID: 16518714 DOI: 10.1007/s10350-006-0514-5]
- 11 **Bols EM**, Hendriks HJ, Berghmans LC, Baeten CG, de Bie RA. Responsiveness and interpretability of incontinence severity scores and FIQL in patients with fecal incontinence: a secondary analysis from a randomized controlled trial. *Int Urogynecol J* 2013; **24**: 469-478 [PMID: 22806487 DOI: 10.1007/s00192-012-1886-9]
- 12 **Li L**, Liu X, Herr K. Postoperative pain intensity assessment: a comparison of four scales in Chinese adults. *Pain Med* 2007; **8**: 223-234 [PMID: 17371409 DOI: 10.1111/j.1526-4637.2007.00296.x]
- 13 **Bordeianou L**, Rockwood T, Baxter N, Lowry A, Mellgren A, Parker S. Does incontinence severity correlate with quality of life? Prospective analysis of 502 consecutive patients. *Colorectal Dis* 2008; **10**: 273-279 [PMID: 17608751 DOI: 10.1111/j.1463-1318.2007.01288.x]
- 14 **Damon H**, Dumas P, Mion F. Impact of anal incontinence and chronic constipation on quality of life. *Gastroenterol Clin Biol* 2004; **28**: 16-20 [PMID: 15041805 DOI: 10.1016/S0399-8320(04)94835-X]
- 15 **Smith TM**, Menees SB, Xu X, Saad RJ, Chey WD, Fenner DE. Factors associated with quality of life among women with fecal incontinence. *Int Urogynecol J* 2013; **24**: 493-499 [PMID: 22806489 DOI: 10.1007/s00192-012-1889-6]
- 16 **Hussain ZI**, Lim M, Stojkovic S. The test-retest reliability of fecal incontinence severity and quality-of-life assessment tools. *Dis Colon Rectum* 2014; **57**: 638-644 [PMID: 24819105 DOI: 10.1097/DCR.0000000000000118]

**P- Reviewer:** Amaro F, Santos-Antunes J, Teo M, Venskutonis D

**S- Editor:** Tian YL **L- Editor:** A **E- Editor:** Li D





## Retrospective Study

## Impact of surgical delay on outcomes in elderly patients undergoing emergency surgery: A single center experience

Marc Ong, Tan Yu Guang, Tan Kok Yang

Marc Ong, Tan Yu Guang, Tan Kok Yang, Department of General Surgery, Khoo Teck Puat Hospital, Singapore 768828, Singapore

**Author contributions:** Ong M designed the study, collected data and wrote the paper; Guang TY collected the data and helped write the paper; Yang TK helped design the study, analyzed the data and helped edit the paper for final submission.

**Institutional review board statement:** The study was reviewed and approved by the Khoo Teck Puat Hospital Institutional Review Board.

**Informed consent statement:** Consent was not obtained in view of retrospective nature of study but the presented data are anonymized and risk of identification is low.

**Conflict-of-interest statement:** There were no conflicts of interest to disclose among the authors.

**Data sharing statement:** Technical appendix, statistical code, and dataset available from the corresponding author at [tan.kok.yang@alexandrahealth.com.sg](mailto:tan.kok.yang@alexandrahealth.com.sg).

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Correspondence to:** Tan Kok Yang, MBBS, MRCS, FRCS, FAMS, Head and Senior Consultant, Department of General Surgery, Khoo Teck Puat Hospital, 90 Yishun Central, Singapore 768828, Singapore. [tan.kok.yang@alexandrahealth.com.sg](mailto:tan.kok.yang@alexandrahealth.com.sg)  
Telephone: +65-66022207  
Fax: +65-66023777

Received: April 22, 2015  
Peer-review started: April 23, 2015  
First decision: June 9, 2015

Revised: June 24, 2015

Accepted: August 4, 2015

Article in press: August 7, 2015

Published online: September 27, 2015

### Abstract

**AIM:** To determine predisposing factors leading to surgical delay in elderly patients with acute abdominal conditions and its impact on surgical outcomes.

**METHODS:** A retrospective review of a total of 144 patients aged 60 years and older who had undergone emergency abdominal surgery between 2010 and 2013 at a regional general hospital was analysed. The operations analysed were limited to perforated or gangrenous viscus and strangulated hernia. Patient demographic features, time taken to obtain a computed tomography scan, time taken to surgery and the impact on postoperative morbidity and mortality were analysed.

**RESULTS:** The mean age was  $70.5 \pm 9.1$  years and median time taken to surgery was 9 h. The overall mortality and complication rates (Clavien Dindo 3 and above) were 9% and 13.1% respectively. Diabetes mellitus was a significant predisposing factor which had an impact on surgical delays. Delays in surgery more than 24 h led to higher complication rates at 38.9% ( $P = 0.003$ ), with multivariate analysis confirming it as an independent factor. Delays in obtaining a computed tomography (CT) scan was also shown to result in higher complication rates (Clavien Dindo 3 and above).

**CONCLUSION:** Delays in performing emergency surgery in elderly lead to higher complication rates. Obtaining CT scans early also may facilitate prompt diagnosis of certain abdominal emergencies where presentation is more equivocal and this may lead to improved surgical outcomes.

**Key words:** Outcomes; Delay; Emergency; Surgery; Elderly

© **The Author(s) 2015.** Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** Emergency surgery in elderly is regarded as a subject matter with growing interest as many countries are faced with an ever increasing aging population. The unique and varied characteristics of the elderly make surgical decisions and management an evolving conundrum and challenge. In this paper, we will discuss the outcomes of elderly patients undergoing emergency surgery in our institution, dwell deeper in possible factors that lead to surgical delay and also look into the relationships between surgical delay and surgical outcomes.

Ong M, Guang TY, Yang TK. Impact of surgical delay on outcomes in elderly patients undergoing emergency surgery: A single center experience. *World J Gastrointest Surg* 2015; 7(9): 208-213 Available from: URL: <http://www.wjgnet.com/1948-9366/full/v7/i9/208.htm> DOI: <http://dx.doi.org/10.4240/wjgs.v7.i9.208>

## INTRODUCTION

Like its many Asian counterparts, Singapore is expected to face an ageing population over the next few decades. As of 2012, the elderly (aged > 65) make up 10.5% of the population, and this number is expected to increase threefold by 2030. The management of elderly population has always been a challenging topic and surgical emergencies of the abdomen are more common in the elderly than in other population<sup>[1,2]</sup>. Yet delays in appropriate surgical treatments are also higher in this population, which translates to poorer morbidity and mortality<sup>[3,4]</sup>. Wakayama *et al*<sup>[5]</sup> noted in gastrointestinal perforations, the mortality is doubled after a delay of > 12 h, eight fold after 24 h, and the tolerance to delay is inversely proportional to age.

There are numerous documented reasons for these delays. Firstly, the elderly population tends to have atypical presentation, with symptoms and signs frequently milder and less specific than in younger adults<sup>[6]</sup>. Some studies also show that elderly patients are generally less likely than younger patients to receive analgesia due to multiple factors including depression, failures in memories and cognitive deficits that may hinder obtaining an accurate pain history<sup>[7]</sup>. More importantly, elderly patients often have multiple medical conditions that require optimizations prior to surgery, which increases the time delay<sup>[8]</sup>. The presence of coexisting diseases is also shown to be a stronger negative prognostic indicator on outcomes when compared to age<sup>[9]</sup>.

Given the conundrums in managing elderly patients, the aim of this study is to report our institution's experience in managing elderly patients undergoing emergency surgeries, paying particular attention to the

factors that lead to delays in early surgical interventions and also the impact of such delays on post-operative morbidity and mortality. Our hypothesis was that delays in surgery translated to poorer outcomes and by analyzing contributing factors to such delays, we could potentially reduce such delays and improve surgical outcomes in the elderly.

## MATERIALS AND METHODS

A retrospective study was performed between 2010 and 2013 on a cohort of 144 elderly patients aged above 65 years old who had undergone emergency abdominal surgery at our institution, Khoo Teck Puat Hospital, Singapore. Since there is no one standard definition of emergency surgery, we defined emergency surgery as those who had undergone surgery within 48 h of admission to the hospital through the Emergency Department for an acute presentation. We limited the study to strangulated hernia, gangrenous or perforated viscus as these were the conditions that required immediate surgery upon diagnosis (unlike some cases of intestinal obstruction).

Pre-operatively, 120 out of 144 patients underwent computed tomography scans of the abdomen and pelvis (CTAP) as part of their diagnostic workup and the other 18 patients had diagnoses confirmed *via* plain radiographs. The remaining 6 patients had clinically irreducible hernias which turned out to have gangrenous bowel.

The primary outcomes measured were mortality and surgical complication rates, based on the Clavien Dindo grading system<sup>[10]</sup>. Delays to surgeries were stratified into 4 groups: 1-6 h, 7-12 h, 13-24 h, and more than 24 h and compared against the rates of in-hospital mortality and complication rates. We defined patients to have major morbidity when they had a complication Clavien-Dindo grade 3 and above either requiring surgical intervention or high dependency/ICU supportive care.

To elucidate possible predisposing factors for surgical delay, we looked at the patients' comorbidities based on the Charlson's weighted comorbidity index. This index is widely used in the geriatric population giving different weights to different comorbidities<sup>[11]</sup>. It was first used to predict lifespan but subsequently had been found to be useful to predict risk of surgery in the geriatric population<sup>[12]</sup>. We also studied other factors including medications, cognition, mobility, nursing home residency, American Society of Anesthesiologists (ASA) physical status classification system and hemodynamic status on admission. We then measured the time interval taken to surgery, defined as time of arrival at the emergency department to the time emergency surgery was performed. In a subgroup of patients, we also measured the time interval taken to complete CTAP upon admission. Multivariate analysis was then performed to compare complication rates and mortality against surgical delays, adjusting for independent effects of predisposing factors on surgical delays.

**Table 1** Distribution of cases according to diagnosis (*n* = 144)

Indications	Patients, <i>n</i> (%)	Mortality <sup>1</sup> , <i>n</i> (%)	Morbidity <sup>2</sup> (Clavien Dindo 3 and above)
Strangulated hernia			
Inguinal	3 (2.0)	0 (0)	0 (0)
Obturator	2 (1.4)	0 (0)	0 (0)
Periumbilical	1 (0.7)	0 (0)	0 (0)
Hollow viscus perforation			
Esophagus	1 (0.7)	0 (0)	0 (0)
Gastric ulcer	39 (27.0)	5 (12.8)	7 (17.9)
Duodenal ulcer	13 (9.0)	0 (0)	3 (23)
Gallbladder	2 (1.4)	0 (0)	0 (0)
Small bowel	12 (8.3)	0 (0)	2 (16.7)
Colonic malignancy	8 (5.6)	3 (37.5)	3 (37.5)
Colonic diverticulitis	6 (4.2)	1 (16.7)	1 (16.7)
Appendix	37 (25.7)	0 (0)	0 (0)
Gangrenous viscus			
Small bowel gangrene	10 (6.9)	4 (40)	4 (40)
Large bowel gangrene	3 (2.0)	0 (0)	0 (0)
Empyema gallbladder	7 (4.8)	0 (0)	0 (0)

<sup>1</sup>Overall mortality *n* = 13 (9%); <sup>2</sup>Overall patients with severe morbidity (Clavien Dindo 3 and above) *n* = 20 (13.8%).

All analyses were done using IBM SPSS statistics ver 20.2. Univariate analyses for categorical variables were done with  $\chi^2$  test and Fisher exact test and continuous data were analyzed by using Student *t* test and analysis of variance method. Multivariate analyses were done using multinomial and binary logistic regression methods. A 2 tailed *P* value of less than 0.05 was taken to be statistically significant in this study.

## RESULTS

A total of 144 patients underwent emergency surgery. The mean age was 70.5 (9.1 SD), with 87 males and 57 females. The two leading causes of surgical emergency were perforated gastric ulcer and perforated appendicitis shown in Table 1. The total number of deaths was 13, representing an overall mortality of 9%. We found that the highest rates of mortality occurred in patients presenting with small bowel gangrene (40%) followed by perforated colonic malignancy (37.5%). There were 6 cases of strangulated hernia but none resulting in death. Table 2 highlights the post-operative outcomes in our series. There were 20 patients which had more serious post-operative complication (Clavien Dindo grade 3 and above), indicating a major morbidity rate of 13.8%. Nine patients required repeat surgery (6.2%) mainly for post-operative bleeding, anastomotic leakage and anastomotic stenosis. The mean length of hospital stay was 11 d.

The median time taken from presentation to surgery was 9 h (range 1-48 h). The primary independent variable of delay in surgery was further categorized into 4 groups for risk estimation: 1-6 h, 7-12 h, 13-24 h, and more than 24 h. Table 3 shows the relationship between the stratified times and the mortality and complication rates. There were no statistically significant

**Table 2** Outcomes after emergency abdominal surgery

Outcome	Patients ( <i>n</i> = 144)	(%)
Surgical		
Post op ileus	11	7.6
Wound infection	13	9
Abdominal abscess	4	2.7
Anastomotic leak	4	2.7
Post op bleeding	2	1.4
Medical		
Respiratory complication	32	22.2
Cardiac complication	20	13.8
Renal complication	12	8.3
Cerebrovascular complication	1	0.7
Thromboembolic complication	5	3.5
Others	6	4.2
Return to OR		
Post op bleeding	2	1.4
Anastomotic leak	4	2.7
Anastomotic stenosis	1	0.7
Abdominal collection	1	0.7
Others	1	0.7

differences in mortality between the groups. But when comparing complication rates, we found that 7 out of 11 patients (38.9%) had complications when surgery was delayed more than 24 h, which was much higher compared to the other groups (*P* = 0.003).

Patients undergoing surgery for any viscus other than the appendix also had a higher mortality rate (13 out of 94) than those with appendiceal diseases (*P* = 0.026). There were no mortalities observed in the latter group. Regardless, after adjusting for ASA, diabetes mellitus, comorbidity index, bedbound patients and nonappendiceal cases, surgeries delayed > 24 h was found to be an independent factor associated with Clavien 3 and above complications; ORs was 12.7 (CI: 1.19-136.5, *P* = 0.035) as highlighted in Table 4.

Of the predisposing factors analyzed which might potentially delay surgical intervention, only diabetes mellitus was found to be a significant factor in patients with surgical delays > 24 h, shown in Table 5. The other factors including cognitive impairment, pre-admission medications, comorbidity index, bedbound state, presence of hypotension on arrival in the ED were found to have no significance on the time taken to surgery.

In a sub-set analysis of the 120 patients who underwent CTAP, the mean time taken to perform at computed tomography (CT) scan was 7.5 h. Incidentally, we noted that patients which required a longer time to perform CT scans ended up with higher complication rates. Table 6 reveals that the mean time taken to perform CT scan in patients with post-operative complications (Clavien Dindo grade 3 and above) was 13.1 h, compared to those with lesser complications being 6.5 h (*P* = 0.006). However again, no association was found between time to CT imaging and mortality rates.

## DISCUSSION

As the number of persons reaching old age continues

**Table 3 Stratified time to surgery against morbidity and mortality**

		Stratified by time to surgery				Total	P value
		1-6 h	6-12 h	13-24 h	> 24 h		
Clavien 2 and below		32	56	25	11	124	0.003 <sup>a</sup>
Clavien 3 and above		7	5	1	7	20	
% of total		17.9%	8.2%	3.8%	38.9%	13.9%	
Total		39	61	26	18	144	0.351
Mortality	No	34	58	24	15	131	
	Yes	5	3	2	3	13	
% of total		12.8%	4.9%	7.7%	16.7%	9%	
Total		39	61	26	18	144	

<sup>a</sup>P < 0.05 statistically significant difference between groups.

**Table 4 Multivariate analysis of factors associated with Clavien Dindo grade 3 and above complications**

Factors	Odds ratio	95%CI	P value
Surgical delay > 24 h	12.75	1.19-136.57	0.035 <sup>a</sup>
Surgical delay > 12 h	0.45	0.05-3.89	0.467
ASA score ≥ 3	0.53	0.16-1.68	0.278
Diabetes mellitus	1.97	0.56-6.87	0.288
Comorbidity index score ≥ 4	0.64	0.06-7.27	0.716
Bedbound patients	1.53	0.09-25.43	0.765

<sup>a</sup>P < 0.05 statistically significant difference between groups. ASA: American Society of Anesthesiologists.

**Table 5 Multivariate analysis of predisposing factors associated with surgical delay > 24 h**

Predisposing factors	Odds ratio	95%CI	P value
ASA score ≥ 3	2.66	0.77-9.26	0.123
Comorbidity index score ≥ 4	1.29	0.19-8.57	0.787
Diabetes mellitus	4.08	1.32-12.55	0.014 <sup>a</sup>
Bedbound patients	0.54	0.02-18.32	0.73
Cognitive impairment	0.45	0.03-6.63	0.566
Chronic analgesia	0.26	0.03-2.33	0.23
Anticoagulants	0.71	0.15-3.36	0.669
Nursing home resident	5.57	0.31-100.25	0.244

<sup>a</sup>P < 0.05 statistically significant difference between groups. ASA: American Society of Anesthesiologists.

to grow, there is a concomitant and imperative need to provide surgical care to an ever increasing number of older patients. There has also been an increase in operations performed for patients older than 65 years old, which is generally accepted as baseline age for geriatric surgery<sup>[13]</sup>. Increased age alone should not be the sole reason to deny surgery in the elderly<sup>[14]</sup>. Van Geloven reported on patients over age 80 who presented to the emergency department with abdominal pain and found 27% required surgery, with an overall mortality of 17% that doubled to 34% among those who required operative intervention<sup>[15]</sup>.

Delays before surgical treatment are often recognized as a contributor to adverse outcomes in emergency surgery and can lead to increased mortality rates<sup>[9,16]</sup>. Our results appears consistent with these studies and

**Table 6 Mean time taken to perform computed tomography against morbidity and mortality**

	n	Mean time taken to perform CTAP	Standard error mean	P value
Clavien 2 and below	19	6.5 h	3.436	0.006 <sup>a</sup>
Clavien 3 and above	101	13.1 h	0.776	
Mortality	Yes	12	11.667	0.119
	No	108	7.139	

<sup>a</sup>P < 0.05 statistically significant difference between groups. CTAP: Computed tomography scans of the abdomen and pelvis.

we noticed a higher rate of post-operative complications (Clavien Dindo grade 3 and above) occurring when surgery was delayed especially when delay was greater than 24 h. With respect to predisposing factors associated with delays greater than 24 h, diabetes mellitus (DM) came up as an independent predisposing factor contributing to delay in surgical intervention as shown in Table 3. We propose that DM could have contributed to a blunted physiological response and hence atypical presentations. FT de Dombal previously described how the case mix and disease evolution is very different in the elderly population and emphasizes the importance of having a greater sense of awareness in diagnosis<sup>[17]</sup>. Similarly, for elderly patients with DM, symptoms may be misleading resulting in diagnostic and possible subsequent surgical delays; hence a high index of suspicion is required.

We believe that the type of surgical emergencies, independent of time, also has a direct impact on the morbidity and mortality. Perforated appendicitis constituted the second most common cause in this study. The incidence of perforation in acute appendicitis is estimated to be 20%-30% but increases to 32%-72% in patients above 60 years of age<sup>[18]</sup>. However, these patients tend to have better outcomes compared to the rest who presented with acute abdomen. In our study, none of the 37 patients who presented with perforated appendicitis had significant morbidity (Clavien 3 and above) or mortality. In stark contrast, we noted a total of 20 morbidities and 13 mortalities in the remaining population. In particular, 40% and 37.5% of patients with small bowel gangrene and perforated colonic



malignancies respectively had significant complications that eventually resulted in death. Guo *et al.*<sup>[19]</sup>, in his study of 233 patients with perforated malignant colonic obstructions, recorded a 24.5% 30-d post-operative mortality, regardless of the Dukes cancer staging. Previous studies have also reported hollow viscus perforations, acute biliary diseases and strangulated hernias accounting for the majority of reasons for emergency surgery in elderly<sup>[14,20]</sup>. These conditions often have similar presentations and early accurate diagnosis is paramount in facilitating appropriate treatment.

Abdominal pain constitutes 10%-15% of all complaints in older persons seen at our Emergency Department and this indolent, nonspecific nature of initial symptom is what makes accurate diagnosis difficult. Radiological imaging is often employed in aiding diagnosis in these conditions, however while advances in diagnostic skills and improvements in diagnostic facilities improve diagnostic accuracy, delay in performing these investigations can impact surgical outcomes<sup>[21]</sup>. Hence we also sought to determine the potential effect of delay in obtaining radiological diagnosis on eventual outcomes as well.

While the leading cause for acute abdomen in our series was peptic ulcer, perforations of small bowel, colonic diverticulitis, colonic malignancies and gallbladder were other causes in our study population. Because of the atypical manifestation of these acute abdominal conditions in the elderly, a CT scan is often helpful. In our series, we noted that in the 120 patients where a CT scan was performed, a greater complication rate (Clavien 3 and above) was observed when the scan was delayed. The mean time to taken to perform CT scan in patients where more serious complications were observed was found to be significantly higher than those with less severe complications as discussed earlier. Delays in performing CT scans in the former group could be attributed to several reasons namely hemodynamically unstable patients requiring further resuscitation and even transferring to high dependency or ICU first, delayed presentation of illness, lack of physical signs at first presentation, inability to illicit proper history from uncommunicative or cognitively impaired patients, and also patients presenting with acute kidney injury requiring intravenous rehydration before performing a contrasted CT scan. The breakdown of the time attributed to the aforementioned factors were not the focus of this particular study but could be looked into with greater detail in subsequent studies.

According to Table 3, we noticed that the overall morbidity seemed to initially decrease with time when surgery was performed within 24 h. However beyond 24 h, it was noted there was the highest percentage of patients with Clavien 3 and above complications (7 out of 18 patients, 38.9%). This bimodal representation could possibly be explained by there being 2 groups of patients: The first group where patients were more stable and diagnosis was made early with resultant earlier operation performed and the second group where

patients were more unstable and required a period of resuscitation first before undergoing an operation. In the latter group, the patients were initially too unstable to perform a CT scan resulting in delayed diagnosis and hence a delay in surgery. The 25 patients who eventually underwent surgery after 24 h were mostly patients already in severe sepsis and this could have explained the majority of them ending up with greater complications post-operatively.

Therefore, we believe that in an elderly population where symptoms of abdominal pain maybe equivocal, the threshold to perform CT scan should be lowered. Once a decision is made to perform a scan, one should expedite its execution to reduce any delays. The earlier a CT scan is performed, the sooner a definitive diagnosis is made and this minimizes total time delay till surgery is performed. Ultimately, we believe this possibly could reduce the severity of post-operative complications especially in patients presenting with the specific conditions in this study. Omari *et al.*<sup>[22]</sup> has also suggested that the early use of CT scan can cut short the way to appropriate treatment for perforated viscus.

There are certain limitations to this study. Firstly, it is a retrospective study and we were unable to take into account the delays which occurred before presentation to the ED. We also did not look into other specific causes which resulted in delays besides those encountered in obtaining CT scans and also the factors that result in a delay in performing a scan. A prospective study can be performed looking at these causes so we can identify other areas to improve and reduce delays in surgery. Lastly, the study also does not include a comprehensive list of all emergency surgeries in the elderly as certain conditions such as cholecystitis and intestinal obstruction are sometimes treated with a trial of conservative management first. The majority of the conditions included in the study were either perforated viscus or gangrenous viscus hence outcome measures should be compared with only this specific group of patients.

Our study demonstrates clearly that delay in performing emergency surgery in elderly lead to higher complication rates. Elderly patients presenting with abdominal pain should be admitted and prudently evaluated with a view to avoid diagnostic and thus surgical delays. Obtaining CT scans early also may potentially facilitate earlier diagnosis of perforated or gangrenous viscus, especially in this group of patients where clinical presentations may be more atypical, and thus possibly lead to improved surgical outcomes.

## COMMENTS

### Background

With an ever increasing ageing population faced in most countries, there is an expected rise in the number of surgical emergencies encountered. Elderly patients are an entirely different group of patients with their multiple comorbidities, cognitive impairment, altered body physiology and more fragile state contributing to the challenges in their management. Many studies have looked into outcomes of emergency surgery but few have focused on the predisposing factors that lead to delay in surgery and how such delays impact

outcomes.

### Research frontiers

Delays in surgery are often inherent in any healthcare system and more studies can be performed to look into the breakdown of each contributing factor with the intention to improve workflow processes and system practices to reduce such delays. With a reduction in delays to surgery, there can be anticipated greater improvements in patient outcomes.

### Innovations and breakthroughs

By studying at the predisposing factors that lead to delay in surgery, the authors can have a higher index of suspicion in certain groups of patients. The authors have found that patients with diabetes mellitus were at higher risk of having a delay in surgery and this could be due to blunted physiologic response. The authors also have noted a delay in performing a computed tomography scan resulted in higher complication rates and hence the authors intend to look into ways to reduce such delays in future studies.

### Applications

The study results suggest that delays in surgery in elderly patients lead to higher complication rates and it is crucial to identify patients with predisposing factors which may lead one to have higher index of suspicion. Such patients should also have any scans (if indicated) expedited to reduce any delays and ultimately improve surgical outcomes as well.

### Terminology

Certain acute abdominal emergencies include perforated or gangrenous viscus and strangulated hernia. Any defect in the walls of abdominal viscus result in peritoneal soiling and eventual peritonitis. Gangrene of the viscus occurs when there is inadequate blood supply most often from vascular occlusion and sepsis usually ensues. Such conditions are usually terminal unless surgical intervention is performed. Hence it is crucial to identify such conditions promptly and initiate surgery at the earliest possible chance to improve outcomes.

### Peer-review

Dr. Ong *et al* reported clinical outcomes in the elderly patients who came to ER in the single center. They reviewed morbidity and mortality of the 144 patients and tried to identify clinical factors to predict poor clinical outcomes. Overall the article is interesting and manuscript is well written.

## REFERENCES

- 1 Bugliosi TF, Meloy TD, Vukov LF. Acute abdominal pain in the elderly. *Ann Emerg Med* 1990; **19**: 1383-1386 [PMID: 2240749 DOI: 10.1016/S0196-0644(05)82602-2]
- 2 Fenyö G. Diagnostic problems of acute abdominal diseases in the aged. *Acta Chir Scand* 1974; **140**: 396-405 [PMID: 4851359]
- 3 Karanikas ID, Liakakos TD, Koundourakis SS, Tzorakis SE, Dendrinos SS. Emergency operations in the elderly: management and outcome. *Int Surg* 1996; **81**: 158-162 [PMID: 8912083]
- 4 Kettunen J, Paajanen H, Kostiainen S. Emergency abdominal surgery in the elderly. *Hepatogastroenterology* 1995; **42**: 106-108 [PMID: 7672756]
- 5 Wakayama T, Ishizaki Y, Mitsusada M, Takahashi S, Wada T, Fukushima Y, Hattori H, Okuyama T, Funatsu H. Risk factors influencing the short-term results of gastroduodenal perforation. *Surg Today* 1994; **24**: 681-687 [PMID: 7981538 DOI: 10.1007/BF01636772]
- 6 Kane E, Fried G, McSherry CK. Perforated peptic ulcer in the elderly. *J Am Geriatr Soc* 1981; **29**: 224-227 [PMID: 7229233 DOI: 10.1111/j.1532-5415.1981.tb01771.x]
- 7 Jones JS, Johnson K, McNinch M. Age as a risk factor for inadequate emergency department analgesia. *Am J Emerg Med* 1996; **14**: 157-160 [PMID: 8924137 DOI: 10.1016/S0735-6757(96)90123-0]
- 8 Escarce JJ, Shea JA, Chen W, Qian Z, Schwartz JS. Outcomes of open cholecystectomy in the elderly: a longitudinal analysis of 21,000 cases in the prelaparoscopic era. *Surgery* 1995; **117**: 156-164 [PMID: 7846619 DOI: 10.1016/S0039-6060(05)80079-0]
- 9 Fenyö G. Acute abdominal disease in the elderly: experience from two series in Stockholm. *Am J Surg* 1982; **143**: 751-754 [PMID: 7091511 DOI: 10.1016/0002-9610(82)90052-6]
- 10 Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004; **240**: 205-213 [PMID: 15273542 DOI: 10.1097/01.sla.0000133083.54934.ae]
- 11 Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987; **40**: 373-383 [PMID: 3558716 DOI: 10.1016/0021-9681(87)90171-8]
- 12 Tan KY, Konishi F, Tan L, Chin WK, Ong HY, Tan P. Optimizing the management of elderly colorectal surgery patients. *Surg Today* 2010; **40**: 999-1010 [PMID: 21046496 DOI: 10.1007/s00595-010-4354-5]
- 13 Rosenthal RA, Zenilman ME. Surgery in the elderly. In: Townsend, Sabiston Textbook of Surgery 18th ed, W.B. Saunders Co, Philadelphia, 2008: 371-398
- 14 Arenal JJ, Bengoechea-Beeby M. Mortality associated with emergency abdominal surgery in the elderly. *Can J Surg* 2003; **46**: 111-116 [PMID: 12691347]
- 15 van Geloven AA, Biesheuvel TH, Luitse JS, Hoitsma HF, Obertop H. Hospital admissions of patients aged over 80 with acute abdominal complaints. *Eur J Surg* 2000; **166**: 866-871 [PMID: 11097153 DOI: 10.1080/110241500447254]
- 16 North JB, Blackford FJ, Wall D, Allen J, Faint S, Ware RS, Rey-Conde T. Analysis of the causes and effects of delay before diagnosis using surgical mortality data. *Br J Surg* 2013; **100**: 419-425 [PMID: 23225342 DOI: 10.1002/bjs.8986]
- 17 de Dombal FT. Acute abdominal pain in the elderly. *J Clin Gastroenterol* 1994; **19**: 331-335 [PMID: 7876517 DOI: 10.1097/0004836-199412000-00016]
- 18 Lee JF, Leow CK, Lau WY. Appendicitis in the elderly. *Aust N Z J Surg* 2000; **70**: 593-596 [PMID: 10945554 DOI: 10.1046/j.1440-1622.2000.01905.x]
- 19 Guo MG, Feng Y, Liu JZ, Zheng Q, Di JZ, Wang Y, Fan YB, Huang XY. Factors associated with mortality risk for malignant colonic obstruction in elderly patients. *BMC Gastroenterol* 2014; **14**: 76 [PMID: 24735084 DOI: 10.1186/1471-230X-14-76]
- 20 Gürleyik G, Gürleyik E, Unalmışer S. Abdominal surgical emergency in the elderly. *Turk J Gastroenterol* 2002; **13**: 47-52 [PMID: 16378274]
- 21 Salem TA, Molloy RG, O'Dwyer PJ. Prospective study on the role of the CT scan in patients with an acute abdomen. *Colorectal Dis* 2005; **7**: 460-466 [PMID: 16108882 DOI: 10.1186/1749-7922-9-6]
- 22 Omari AH, Khammash MR, Qasaimeh GR, Shammari AK, Yaseen MK, Hammori SK. Acute appendicitis in the elderly: risk factors for perforation. *World J Emerg Surg* 2014; **9**: 6 [PMID: 24428909]

P- Reviewer: Barreto S, Koda K, Mizuguchi T, Palermo M

S- Editor: Ji FF L- Editor: A E- Editor: Li D



## Prospective Study

## Laying open (deroofing) and curettage under local anesthesia for pilonidal disease: An outpatient procedure

Pankaj Garg, Mahak Garg, Vikas Gupta, Sudhir Kumar Mehta, Paryush Lakhtaria

Pankaj Garg, Mahak Garg, Department of Colorectal Surgery, Indus Super Specialty Hospital, Mohali 160055, Punjab, India

Pankaj Garg, Mahak Garg, Sudhir Kumar Mehta, Department of Colorectal Surgery, Garg Fistula Research Institute, Panchkula, Haryana 134113, India

Vikas Gupta, Department of General Surgery, Post Graduate Institute of Medical Education and Research, Chandigarh 160012, India

Paryush Lakhtaria, Department of Colorectal Surgery, New York Hospital Medical Centre of Queens, Colorectal Surgery, New York, NY 10461, United States

**Author contributions:** Garg P thought of the concept; Garg P, Garg M, Gupta V, Mehta SK and Lakhtaria P designed the study, acquired the data, analyzed it, drafted, revised and finally approved the draft; Garg P submitted the manuscript.

**Institutional review board statement:** The study was reviewed and approved by the Indus Hospital Ethical Committee.

**Informed consent statement:** All study participants, or their legal guardian, provided informed written consent prior to study enrollment.

**Conflict-of-interest statement:** None of the authors have received fees for serving as a speaker or as a position (such as consultant and/or an advisory board member) which could have a conflict of interest with this study. None of the authors have received research funding from any organization or individual. None of the authors is an employee of an organization, or owns stocks and/or shares in name of an organization which has potential conflict of interest with the study.

**Data sharing statement:** Technical appendix, statistical code, and dataset available from the corresponding author at [drargpankaj@yahoo.com](mailto:drargpankaj@yahoo.com). No consent was not obtained but the presented data are anonymized and risk of identification is low.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative

Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Correspondence to:** Dr. Pankaj Garg, Department of Colorectal Surgery, Garg Fistula Research Institute, Sector-15, Panchkula, Haryana 134113, India. [drargpankaj@yahoo.com](mailto:drargpankaj@yahoo.com)  
Telephone: +91-950-1011000  
Fax: +91-172-2594556

Received: May 4, 2015  
Peer-review started: May 5, 2015  
First decision: June 3, 2015  
Revised: June 10, 2015  
Accepted: July 21, 2015  
Article in press: July 23, 2015  
Published online: September 27, 2015

### Abstract

**AIM:** To test the efficacy of lay open (deroofing, not excision) with curettage under local anesthesia (LOCULA) for pilonidal sinus as an outpatient procedure.

**METHODS:** LOCULA procedure was done for all types of pilonidal disease. The primary outcome measure was cure rate. The secondary outcome measures were hospital stay, operating time, return to work, healing time and complication rate.

**RESULTS:** Thirty-three (M/F-30/3, mean age-23.4 ± 5.8 years) consecutive patients were operated and followed for 24 mo (6-46 mo). Eleven were pilonidal abscess and 22 were chronic pilonidal disease. Six had recurrent disease. Operating time and the hospital stay was 22.3 ± 5.6 min and 63.8 ± 22.3 min respectively. The patients could resume normal work in 4.3 ± 3.2 d and the healing time was 42.9 ± 8.1 d. Thirty (93.8%)

patients had complete resolution of the disease and two (6.2%) had a recurrence. Both the recurrences happened in patients who had complete healing but ignored the prescribed recommendations. One out of these got cured after getting operated again with the same procedure. Thus the overall success rate of this procedure was 96.9%.

**CONCLUSION:** Lay open (deroofing) with curettage procedure under local anesthesia is an effective procedure to treat both simple and complicated pilonidal sinus and abscess. It is a simple procedure, has a high cure rate (up to 97%), doesn't require admission and is associated with minimal morbidity and scarring. Considering the distinct advantages, this procedure has the potential to become the first line procedure for treating pilonidal disease.

**Key words:** Pilonidal; Lay open; Deroofing; Curettage; Sinus

© The Author(s) 2015. Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** This study demonstrates that lay open with curettage under local anesthesia is a simple procedure to treat simple and complicated pilonidal disease. It is quite effective with high cure rate and can be done as an outpatient procedure. Apart from this, this procedure has distinct advantages - can be learnt easily, less time to operate, almost pain free, back to work faster, minimum incision, simple dressings after operation, small scar, minimal change in body shape, economically better and easy to repeat after a recurrence. This procedure can potentially become the frontline operation for all types of pilonidal disease.

Garg P, Garg M, Gupta V, Mehta SK, Lakhtaria P. Laying open (deroofing) and curettage under local anesthesia for pilonidal disease: An outpatient procedure. *World J Gastrointest Surg* 2015; 7(9): 214-218 Available from: URL: <http://www.wjgnet.com/1948-9366/full/v7/i9/214.htm> DOI: <http://dx.doi.org/10.4240/wjgs.v7.i9.214>

## INTRODUCTION

"Pilonidal sinus" as a term was first used in the year 1880<sup>[1]</sup>. Though Mayo described this disease in detail in 1833, its optimal treatment is debated even today<sup>[2]</sup>. Several procedures have been described for pilonidal disease. Acute abscess is treated by incision and drainage<sup>[3]</sup>. Chronic disease is usually treated by wide excision. After excising, the wound may be left open so that it heals with granulation tissue<sup>[4]</sup>, or the wound may be closed on the operating table. The latter may be a midline closure<sup>[5]</sup> or usage of a flap - Z-plasty<sup>[6]</sup>, Karydakias flap<sup>[7]</sup>, Bascom flap<sup>[8]</sup> and Limberg flap<sup>[9]</sup>. The principle behind these extensive procedures had been to remove all the diseased portion and to close the wound

away from the midline<sup>[10,11]</sup>. However, these excisional procedures lead to extensive incisions, removal of large amount of skin, big wounds and hence increase morbidity. In spite of increased morbidity, the recurrence rate also didn't necessarily come down after these extensive procedures<sup>[12-14]</sup>.

Laying open of pilonidal sinus and curettage of tract under local anesthesia (LOCULA) procedure is a simple procedure to manage pilonidal sinus<sup>[15,16]</sup>. Though this procedure has been described in the past yet no study has determined the feasibility and efficacy of this procedure done under local anesthesia as an office procedure.

We performed a prospective study between 2011 and 2014 to analyze the benefits and drawbacks of this procedure in all types of pilonidal disease - acute (abscess), chronic simple and complicated (recurrent, multiple tracts, etc.).

## MATERIALS AND METHODS

### Study population

In the period between January 2011 and July 2014, all the consecutive patients of pilonidal sinus (simple as well as complicated) were prospectively included in the study. The inclusion criteria were: Patients with chronic simple pilonidal sinus, patients having recurring disease and pilonidal disease having an associated abscess. All patients gave consent in writing in the language they understood. The hospital ethics committee approved the study protocol. All the operations were performed by a single surgeon (Garg P).

### Surgical procedure

No preoperative preparation was done. All the procedures were done on an outpatient basis under local anesthesia and no hospital admission was done. No patient required general or spinal anesthesia. During operation, the patient was placed in a prone position. An adhesive tape was used to separate the buttocks so that proper exposure of the diseased area could be obtained. The solution of Povidine iodine was used to disinfect the operative area.

The sinus opening was probed gently to gauge the direction and length of the tract (Figure 1). The local anesthetic agent (2% Lignocaine with Adrenaline 0.005%) was infiltrated around the opening and along the tract/tracts (Figure 1). The anesthetic agent was kept ready in case the tracts were found to be longer than expected or any side tract was encountered. The tracts were identified with the help of mosquito (small artery) forceps and were laid open (Figure 1). If there were more than one tracts, then all the tracts were opened at the same time. All the hairs and debris were removed from the tracts (Figure 1) and all the granulation tissue was removed by rubbing the sinus cavity with a dry gauze or with a curette. The skin edges were trimmed. The wound was checked thoroughly for any extensions or side/downward branches. The





**Figure 1** Lay open plus curettage under local anesthesia procedure for pilonidal disease. A: Preoperative photo without preparation; B: Preoperative photo after preparation; C: Infiltration of local anesthesia; D: Laying open after inserting an artery forceps in the sinus; E: Hairs and debris removed from the sinus; F: Immediate post-operative; G: One week postoperative; H: Three weeks post-operative; I: Completely healed wound - 6 wk postoperative.

lateral wall and the base of the sinus were left intact and no marsupialization was done. The bleeding points were electrocauterized and haemostasis achieved. The wound was packed tightly with a povidone iodine soaked gauze.

The patient walked off to the recovery room and kept under observation for an hour. After this, the dressing was checked for any active bleeding and the patient was sent back home with instructions to resume daily routine. However, he/she was instructed to avoid strenuous work. Oral antibiotic (Cefixime 200 mg twice a day) and analgesic (Aciclofenac 500 mg) were prescribed twice a day for five days.

#### Follow-up

All the patients were examined in the out-patient office on the next day of operation. The dressing was taken off, the wound gently rubbed with a dry gauze and then

lightly packed with a povidine iodine soaked gauze. The process was explained to the relative and the latter was made to do the same under our supervision. After this, the patient's relative was instructed to clean the operated area at home (once or twice a day) and the patient was encouraged to resume his normal work as soon as possible. The patient was followed up on weekly basis till the wound healed completely.

After the wound healed completely, the patient was instructed to keep three centimeters area all around the wound free of hair till he/she reached the age of thirty years. He/she was also advised to put powder in the intergluteal cleft for the same period (India is a hot and humid country and increased sweating and moistness in the intergluteal region was reported by all our patients. We suspected this to be one of the contributing reasons). The patient was told to report back in case of any swelling, pain or pus discharge from the operated

**Table 1 Demographic data and characteristics of the patients**

Parameter	n = 33
Age	23.4 ± 5.8 yr
Sex (M/F)	30/3
Anesthesia	Local anesthesia
Inclusion criteria	Chronic, recurrent, abscess
Exclusion criteria	Refused consent
Recurrent	6 (18.2%)
Abscess	11 (33%)

M/F: Male/female.

**Table 2 Results about the recurrences of the patients**

Parameter	n = 33
Operating time	22.3 ± 5.6 min
Hospital stay	63.8 ± 22.3 min
Resume normal work	4.3 ± 3.2 d
Healing time	42.9 ± 8.1 d
Recurrence	6.2%
Complications	3.1%

area.

## RESULTS

The various characteristics of the patients are summarized in Table 1. Thirty three consecutive patients were prospectively recruited over a three and a half years period. The patients had a 24 mo of median (range: 6-46 mo) follow-up. One patient was lost to follow up. The age of the patients ranged from 16 to 39 years (mean: 23.4 ± 5.8) and the sex ratio-M/F - 30/3. Eleven were pilonidal abscess and 22 were chronic pilonidal disease. Six had recurrent disease. The operating time was 22.3 ± 5.6 min and the hospital stay after the operation was 63.8 ± 22.3 min. The patients were able to resume their normal work in 4.3 ± 3.2 d and the healing time was 42.9 ± 8.1 d. Thirty (93.8%) patients had complete resolution of the disease and two (6.2%) had a recurrence (Table 2). Both the recurrences happened in the patients who didn't adhere to the prescribed recommendations after the complete healing. One patient with a recurrence was operated again with the same procedure and he got cured. The second patient was lost to follow up. Thus the overall cure rate was 96.9%. One patient had a bleeding episode six days after the operation. She was managed conservatively in the outpatient clinic and the wound got healed subsequently.

## DISCUSSION

In this study, LOCULA was done on an outpatient basis in 33 patients with 96.9% success rate. All types of pilonidal sinus patients, simple and complicated (recurrent, abscess and multiple tracts) were included in the study. This is perhaps the first study in the literature which demonstrated that this simple procedure was

highly effective (low recurrence rate) and could be done on outpatient basis without the need for hospital admission. This was possible because LOCULA could be done under local anesthesia. None of the patient required general or regional anesthesia. This makes it quite cost effective as well. The morbidity was minimal as the procedure was done under local anesthesia on an outpatient basis (all the patients left the hospital within one and a half hour after the procedure) and could resume their normal routine within a week (mean: 4.3 d). The recurrence happened in only two (6.2%) patients and one of them underwent the same procedure and got cured. The recurrence also happened in those patients who didn't follow the post-operative instructions (to regularly clean the area of hair). The only drawback seen in this procedure was slightly longer healing time (6 wk). But this delayed healing time did not interfere with the normal routine and resumption of work, hence didn't bother the patient much.

During the operation, no attempt was made to excise the sinus. Only laying open (deroofting) was done and some trimming of the lateral walls was done to prevent adhesions and ensure healing by secondary intention. This made the procedure simple, took less time, led to minimal bleeding and resulted in a small wound. The postoperative pain was very less and the wound care was not demanding.

Though lay open with curettage procedure had shown to be effective in the past<sup>[15,16]</sup>, yet it could not become the preferred procedure for treating pilonidal disease. One of the reasons could be that this procedure was perhaps confused with another procedure - drainage of acute abscess in pilonidal disease after simply incising it (without curetting the tracts and the cavity). The latter procedure was associated with a recurrence rate of up to 24%<sup>[3,17-19]</sup>. However, when the cavity was curetted along with the drainage, the recurrence rate reduced significantly. In a large study (150 patients) with long follow-up (65 mo), Vahedian *et al*<sup>[19]</sup> compared the success rate of only drainage procedure vs laying open with curettage and found that the cure rate in these procedures differed significantly (simple drainage group - 46%, curettage group - 90%). This is not difficult to understand because when the wound is thoroughly curetted, all the debris, hairs and granulation tissue are removed and any side branches/extensions are easily identified. The latter can then be laid opened and curetted.

To conclude, LOCULA is a simple procedure to treat simple and complicated pilonidal disease. It is quite effective with high cure rate and can be done as an outpatient procedure. Apart from this, this procedure has distinct advantages - can be learnt easily, less time to operate, almost pain free, back to work faster, minimum incision, simple dressings after operation, small scar, minimal change in body shape, economically better and easy to repeat after a recurrence. This procedure has full potential to become the gold standard operation for all types of pilonidal disease. The only slight drawback is slightly longer healing time but this aspect doesn't



much bother patients as they can carry out their normal chores during the dressing period.

## COMMENTS

### Background

Pilonidal sinus is a dreaded disease in which a tract (sinus) is formed in the lower back inside which there is a collection of hairs. This usually happens in sedentary, sweaty, slightly obese, hairy young males. This disease is characterized by regular pus formation and is notorious for recurrence after the operation.

### Research frontiers

As of today, chronic disease is usually treated by wide excision. After excising, the wound may be left open so that it heals with granulation tissue, or the wound may be closed on the operating table. The latter may be a midline closure or usage of a flap - Z-plasty, Karydakias flap, Bascom flap and Limberg flap. However these extensive big operative procedures require administration of spinal or general anesthesia, hospital admission for 2-3 d and bed rest for 5-10 d. The resumption of normal work can take up to 4-6 wk. In spite of all this, the recurrence rate also is also 4%-10% after these extensive procedures.

### Innovations and breakthroughs

This is the first study which demonstrates that a simple procedure (lay open with curettage) can treat simple and complicated pilonidal disease in an effective manner. This procedure can be done as an outpatient procedure without needing any hospital admission. Therefore, no hospital admission is required. Apart from this, this procedure has distinct advantages - can be learnt easily, less time to operate, almost pain free, back to work faster, minimum incision, simple dressings after operation, small scar, minimal change in body shape, economically better and easy to repeat after a recurrence.

### Applications

As this simple procedure has so many distinct advantages over all other preferred procedures, this procedure can potentially become the frontline operation for all types of pilonidal disease.

### Terminology

Pilonidal sinus - a tract or a sinus in the lower back in which a cluster of hairs go in leading to recurrent infection and pus formation. Excisional procedures - operations in which the sinus is removed by operation taking a big margin all around which results in a large wound.

### Peer-review

This study presented a novel procedure to treat simple and complicated pilonidal disease. The data was full and accurate. And the authors present a study on a modified approach to the operative treatment of pilonidal sinus disease. It's an interesting and simple surgical procedure with good short-term results.

## REFERENCES

- Hodges RM. Pilonidal sinus. *Boston Med Surg J* 1880; **103**: 485-486 [DOI: 10.1056/NEJM188011181032101]
- Mayo O. Observations on injuries and diseases of the rectum. London: Burgess and Hill, 1833
- Jensen SL, Harling H. Prognosis after simple incision and drainage for a first-episode acute pilonidal abscess. *Br J Surg* 1988; **75**: 60-61 [PMID: 3337954 DOI: 10.1002/bjs.1800750122]
- Testini M, Piccinni G, Miniello S, Di Venere B, Lissidini G, Nicolardi V, Bonomo GM. Treatment of chronic pilonidal sinus with local anaesthesia: a randomized trial of closed compared with open technique. *Colorectal Dis* 2001; **3**: 427-430 [PMID: 12790943 DOI: 10.1046/j.1463-1318.2001.00278.x]
- Bissett IP, Isbister WH. The management of patients with pilonidal disease--a comparative study. *Aust N Z J Surg* 1987; **57**: 939-942 [PMID: 3439938 DOI: 10.1111/j.1445-2197.1987.tb01298.x]
- Monro RS, Mcdermott FT. The elimination of causal factors in pilonidal sinus treated by Z-Plasty. *Br J Surg* 1965; **52**: 177-181 [PMID: 14261120 DOI: 10.1002/bjs.1800520306]
- Karydakias GE. New approach to the problem of pilonidal sinus. *Lancet* 1973; **2**: 1414-1415 [PMID: 4128725 DOI: 10.1016/S0140-6736(73)92803-1]
- Bascom J, Bascom T. Utility of the cleft lift procedure in refractory pilonidal disease. *Am J Surg* 2007; **193**: 606-609; discussion 609 [PMID: 17434365 DOI: 10.1016/j.amjsurg.2007.01.008]
- Bozkurt MK, Tezel E. Management of pilonidal sinus with the Limberg flap. *Dis Colon Rectum* 1998; **41**: 775-777 [PMID: 9645748 DOI: 10.1007/BF02236268]
- McCallum I, King PM, Bruce J. Healing by primary versus secondary intention after surgical treatment for pilonidal sinus. *Cochrane Database Syst Rev* 2007; **(4)**: CD006213 [PMID: 17943897 DOI: 10.1002/14651858.cd006213.pub2]
- McCallum IJ, King PM, Bruce J. Healing by primary closure versus open healing after surgery for pilonidal sinus: systematic review and meta-analysis. *BMJ* 2008; **336**: 868-871 [PMID: 18390914 DOI: 10.1136/bmj.39517.808160.BE]
- Gencosmanoglu R, Inceoglu R. Modified lay-open (incision, curettage, partial lateral wall excision and marsupialization) versus total excision with primary closure in the treatment of chronic sacrococcygeal pilonidal sinus: a prospective, randomized clinical trial with a complete two-year follow-up. *Int J Colorectal Dis* 2005; **20**: 415-422 [PMID: 15714292 DOI: 10.1007/s00384-004-0710-5]
- Karakayali F, Karagulle E, Karabulut Z, Oksuz E, Moray G, Haberal M. Unroofing and marsupialization vs. rhomboid excision and Limberg flap in pilonidal disease: a prospective, randomized, clinical trial. *Dis Colon Rectum* 2009; **52**: 496-502 [PMID: 19333052 DOI: 10.1007/DCR.0b013e31819a3ec0]
- Lorant T, Ribbe I, Mahteme H, Gustafsson UM, Graf W. Sinus excision and primary closure versus laying open in pilonidal disease: a prospective randomized trial. *Dis Colon Rectum* 2011; **54**: 300-305 [PMID: 21304300 DOI: 10.1007/DCR.0b013e31820246bf]
- Kepekci I, Demirkan A, Celasin H, Gecim IE. Unroofing and curettage for the treatment of acute and chronic pilonidal disease. *World J Surg* 2010; **34**: 153-157 [PMID: 19820992 DOI: 10.1007/s00268-009-0245-6]
- Al-Homoud SJ, Habib ZS, Abdul Jabbar AS, Isbister WH. Management of sacrococcygeal pilonidal disease. *Saudi Med J* 2001; **22**: 762-764 [PMID: 11590447]
- Matter I, Kunin J, Schein M, Eldar S. Total excision versus non-resectional methods in the treatment of acute and chronic pilonidal disease. *Br J Surg* 1995; **82**: 752-753 [PMID: 7627503 DOI: 10.1002/bjs.1800820612]
- Allen-Mersh TG. Pilonidal sinus: finding the right track for treatment. *Br J Surg* 1990; **77**: 123-132 [PMID: 2180534 DOI: 10.1002/bjs.1800770203]
- Vahedian J, Nabavizadeh F, Nakhac N, Vahedian M, Sadeghpour A. Comparison between drainage and curettage in the treatment of acute pilonidal abscess. *Saudi Med J* 2005; **26**: 553-555 [PMID: 15900358]

P- Reviewer: Scheidbach H, Wang JS

S- Editor: Tian YL L- Editor: A E- Editor: Li D



## Acute pancreatitis complicated with splenic rupture: A case report

Bruno L Hernani, Pedro C Silva, Ricardo T Nishio, Henrique C Mateus, José C Assef, Tercio De Campos

Bruno L Hernani, Pedro C Silva, Ricardo T Nishio, Irmandade da Santa Casa de Misericórdia de São Paulo Hospital, Santa Casa School of Medicine, São Paulo 01221-020, Brazil

Henrique C Mateus, José C Assef, Tercio De Campos, Department of Surgery, Emergency Unit, Irmandade da Santa Casa de São Paulo Hospital, Santa Casa School of Medicine, São Paulo 01221-020, Brazil

**Author contributions:** Assef JC and De Campos T conceived of and designed the study and critically revised the paper; Hernani BL, Silva PC and Nishio RT acquired the data; Mateus HC analyzed the data; Mateus HC, Assef JC and De Campos T contributed technical procedures; Hernani BL, Silva PC, Nishio RT and Mateus HC interpreted the data; Silva PC and Nishio RT contributed to manuscript preparation; Hernani BL wrote the manuscript.

**Institutional review board statement:** Approval was obtained from the local ethical committee for the publication of this report.

**Informed consent statement:** Written informed consent was obtained from the patient for the publication of this report.

**Conflict-of-interest statement:** The authors declare that they have no competing interests.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Correspondence to:** Bruno L Hernani, MD, Digestive Surgery Resident, Irmandade da Santa Casa de Misericórdia de São Paulo Hospital, Santa Casa School of Medicine, Rua Dr Cesário Mota Jr 112, São Paulo 01221-020, Brazil. [drbrunohernani@gmail.com](mailto:drbrunohernani@gmail.com)  
Telephone: +55-11-21767000  
Fax: +55-11-21767000

Received: April 4, 2015  
Peer-review started: April 12, 2015

First decision: May 13, 2015

Revised: June 16, 2015

Accepted: July 11, 2015

Article in press: July 14, 2015

Published online: September 27, 2015

### Abstract

Atraumatic splenic rupture is an uncommon complication of acute pancreatitis. This report describes the case of a 30-year-old man with acute pancreatitis and splenic vein thrombosis complicated by splenic rupture. The patient was admitted to the emergency department with pain in the upper abdomen that had been present for six hours and was associated with vomiting and sweating. He was diagnosed with acute pancreatitis of alcoholic etiology. Upon computed tomography (CT) of the abdomen, the pancreatitis was scored as Balthazar C grade, and a suspicious area of necrosis affecting 30% of the pancreas with splenic vein thrombosis was revealed. Seventy-two hours after admission, the patient had significant improvement in symptoms. However, he showed clinical worsening on the sixth day of hospitalization, with increasing abdominal distension and reduced hemoglobin levels. A CT angiography showed a large amount of free fluid in the abdominal cavity, along with a large splenic hematoma and contrast extravasation along the spleen artery. The patient subsequently underwent laparotomy, which showed hemoperitoneum due to rupture of the splenic parenchyma. A splenectomy was then performed, followed by ultrasound-guided percutaneous drainage.

**Key words:** Acute pancreatitis; Pancreatitis; Rupture; Splenic rupture; Spontaneous

© **The Author(s) 2015.** Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** This report describes a rare case of atraumatic splenic rupture that occurred in a 30-year-old male



patient with acute pancreatitis and splenic vein thrombosis. A computed tomography angiography showed a large amount of free fluid in the abdominal cavity, along with a large splenic hematoma and contrast extravasation along the spleen artery. The patient underwent a splenectomy followed by ultrasound-guided percutaneous drainage.

Hernani BL, Silva PC, Nishio RT, Mateus HC, Assef JC, De Campos T. Acute pancreatitis complicated with splenic rupture: A case report. *World J Gastrointest Surg* 2015; 7(9): 219-222 Available from: URL: <http://www.wjgnet.com/1948-9366/full/v7/i9/219.htm> DOI: <http://dx.doi.org/10.4240/wjgs.v7.i9.219>

## INTRODUCTION

Atraumatic splenic rupture is a rarely reported complication of acute pancreatitis<sup>[1]</sup>. Approximately 10% of atraumatic splenic ruptures are related to local inflammatory processes<sup>[2]</sup>. These ruptures can be accompanied by other complications, such as perisplenic/intrasplenic pseudocysts, splenic infarction, subcapsular hematomas, and intrasplenic hemorrhage<sup>[3-6]</sup>. Morbidity and mortality rates for pancreatitis with splenic complications vary from 39% to 79% and 3.5% to 0.8%, respectively<sup>[7]</sup>, demonstrating the importance of prompt recognition. This report describes a rare case involving a patient with acute pancreatitis and splenic vein thrombosis complicated by splenic rupture.

## CASE REPORT

A 30-year-old man was admitted to the emergency department with pain in the upper abdomen that had been present for six hours accompanied by vomiting and sweating. He reported chronic alcoholic abuse, including recent consumption prior to the onset of symptoms. He had no other comorbidities. An initial examination showed normal blood pressure, a heart rate of 120 bpm, respiratory rate of 40 ipm, and a distended abdomen that was painful to palpation but with no signs of peritonitis. Laboratory exams showed: amylase, 199 IU/L; lipase, 410 U/L; C-reactive protein, 56 mg/L; WBC,  $14.8 \times 10^6/\mu\text{L}$ , hemoglobin, 18.1 g/dL hematocrit 52% pH7.30  $\text{HCO}_3^-$ , 12.7 mmol/L; lactate, 5.0 mmol/L. A diagnosis of alcoholic pancreatitis was confirmed. The Apache II classification was 2 at admission.

A computed tomography (CT) of the abdomen indicated that the pancreatitis was Balthazar grade C, and a suspicious area of necrosis affecting 30% of the pancreas with splenic vein thrombosis was observed (Figure 1). The patient was given antibiotics because of an increased C-reactive protein level (326 mg/L at 48 h after admission) and necrosis of the pancreas. The patient's symptoms substantially improved after

72 h, with acceptance of an oral diet. However, clinical worsening occurred on the sixth day of hospitalization, with increasing abdominal distension and a reduced hemoglobin level (9.2 g/dL). Diagnostic paracentesis was then conducted on hematic content output. A subsequent CT angiography of the abdomen revealed a large amount of free fluid in the abdominal cavity, a large splenic hematoma, and contrast extravasation along the spleen artery (Figure 2).

The patient underwent a laparotomy, which showed hemoperitoneum due to the rupture of the splenic parenchyma and surrounding hematoma. A splenectomy was thus performed with cavity drainage. The patient was administered norepinephrine and blood components replacement. Six days after the operation, he was hemodynamically stable without vasoactive drugs and extubated; he showed acceptance of enteral nutrition and no signs of pancreatic fistula.

Forty-eight hours after withdrawal of antibiotics, on postoperative day 20, the patient exhibited a fever. Abdominal CT revealed peripancreatic collection of liquefied content and gas. He subsequently underwent ultrasound-guided percutaneous drainage with a Shiley catheter, which provided purulent content. CT performed after the procedure showed a significant decrease in the collection volume. Seven days after drainage, the fever returned and a second percutaneous procedure was performed, which resolved the fluid collection. The patient was subsequently discharged, with no complaints at a 30-d follow-up.

## DISCUSSION

Splenic complications are considered rare events during the course of acute and chronic pancreatitis and have varied descriptions, including pseudocyst, subcapsular hematoma, splenic infarction, intrasplenic hemorrhage, and splenic rupture. Subcapsular hematomas, pseudocysts, and splenic rupture are more common in chronic pancreatitis<sup>[8]</sup>, whereas splenic infarctions and intrasplenic hemorrhage tend to be more frequent in acute pancreatitis<sup>[9]</sup>.

The anatomic relationship between the pancreatic tail and the splenic hilum contributes to the pathology of splenic complications<sup>[10]</sup>. For example, splenic rupture is more often described as a complication of chronic pancreatitis, where it occurs secondary to the enzymatic erosion of pseudocysts or as a result of direct action in the splenic parenchyma. In contrast, it has been reported in acute pancreatitis following splenic vein thrombosis, perisplenic adhesions, and acute inflammation of ectopic intrasplenic pancreatic tissue<sup>[3,8]</sup>. The cause of the splenic rupture in the present case was likely the splenic vein thrombosis observed in the first CT scan, as the histopathologic finding was sinusoidal hypertension in the spleen.

The diagnosis of splenic complications is challenging due to the absence of specific symptoms and signs.

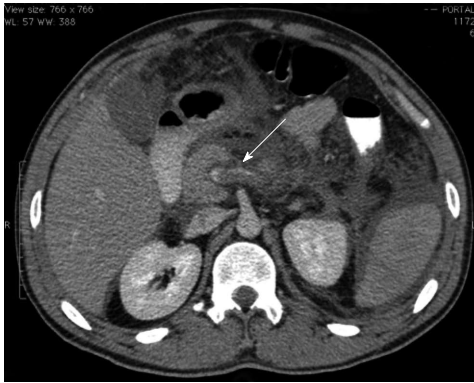


Figure 1 Abdominal computed tomography showing Balthazar C pancreatitis with splenic vein thrombosis (arrow).

However, the presence of pain in the left upper quadrant and referred pain in the left shoulder are indications. Thus, CT is valuable for identifying splenic complications, as well as for patient follow-up, as demonstrated in the case presented here. Magnetic resonance imaging may also be useful, as it allows for better characterization of the various soft tissues and vascular alterations compared to CT<sup>[8]</sup>. Furthermore, the case presented here suggests that worsening of abdominal pain and distension followed by acute anemia are clinical indicators for diagnosis. A diagnostic paracentesis was also performed on the patient in this case, followed by CT angiography, which was used to locate the hemorrhage.

The treatment of splenic complications depends upon the hemodynamic status of the patient. A variety of treatments can be considered for patients who are hemodynamically stable, including a conservative approach, percutaneous drainage, angiography study, embolization, or even surgery. However, use of a conservative approach requires strict follow-up with serial ultrasound or CT. In contrast, surgical intervention with splenectomy or distal pancreatectomy is convenient for patients who are hemodynamically unstable<sup>[8,9]</sup>. As the patient in the present case was hemodynamically stable, the first choice was angiography study followed by embolization. However, technical problems and clinical worsening of the patient led to the need for a laparotomy followed by splenectomy and drainage of the abdominal cavity. Importantly, despite signs of pancreatic necrosis, no necrosectomy was performed as the patient was treated for hemorrhagic complications rather than the pancreatitis. Indeed, necrosectomy is not recommended in the early phase of the disease<sup>[10]</sup>, and thus, the maximal procedure recommended for this patient was drainage.

Even though splenic complications are rare conditions in both acute and chronic pancreatitis, clinical suspicion and prompt diagnosis using CT or other imaging methods are important for the patient's prognosis. As this condition can change in a short period of time, early diagnosis followed by appropriate treatment can dramatically alter the morbidity and mortality associated with splenic rupture.



Figure 2 Abdominal computed tomography angiography showing a large amount of free fluid and a splenic hematoma (arrows).

## COMMENTS

### Case characteristics

Thirty years old man with pain in the upper abdomen that had been present for six hours and associated with vomiting and sweating.

### Clinical diagnosis

Acute pancreatitis.

### Differential diagnosis

Subcapsular hematoma, intrasplenic haemorrhage, and necrotizing hemorrhagic pancreatitis.

### Laboratory diagnosis

Amylase, 199 IU/L; Lipase, 410 U/L; C-reactive protein, 56 mg/L; WBC,  $14.8 \times 10^9/\mu\text{L}$ ; hemoglobin, 18.1 g/dL hematocrit 52% pH7.30,  $\text{HCO}_3^-$ , 12.7 mmol/L; lactate, 5.0 mmol/L.

### Imaging diagnosis

Computed tomography (CT) of the abdomen showed Balthazar grade C with pancreatic necrosis and CT angiography revealed a large amount of free fluid in the abdominal cavity, a large splenic hematoma, and contrast extravasation along the spleen artery.

### Treatment

Splenectomy was performed with cavity drainage.

### Related reports

Atraumatic splenic rupture is a very rare complication of acute pancreatitis, with few reports in the literature.

### Experiences and lessons

Even though splenic complications are rare, a clinical suspicion and prompt diagnosis are critically important for a positive patient prognosis; because this condition can change in a short period of time, an early diagnosis followed by appropriate treatment was helpful in this case.

### Peer-review

The case report by Hernani *et al* presents a case of a young adult male who developed a splenic rupture associated with an episode acute pancreatitis. The authors briefly discuss the relationship of this complication to pancreatic inflammation, its presenting signs and symptoms, and recommended therapy.

## REFERENCES

1. Toussi HR, Cross KS, Sheehan SJ, Bouchier-Hayes D, Leahy AL. Spontaneous splenic rupture: a rare complication of acute

- pancreatitis. *Br J Surg* 1996; **83**: 632 [PMID: 8689204]
- 2 **Renzulli P**, Hostettler A, Schoepfer AM, Gloor B, Candinas D. Systematic review of atraumatic splenic rupture. *Br J Surg* 2009; **96**: 1114-1121 [PMID: 19787754 DOI: 10.1002/bjs.6737]
- 3 **Patil PV**, Khalil A, Thaha MA. Splenic parenchymal complications in pancreatitis. *JOP* 2011; **12**: 287-291 [PMID: 21546711]
- 4 **Tseng CW**, Chen CC, Chiang JH, Chang FY, Lin HC, Lee SD. Percutaneous drainage of large subcapsular hematoma of the spleen complicating acute pancreatitis. *J Chin Med Assoc* 2008; **71**: 92-95 [PMID: 18290254]
- 5 **Gandhi V**, Philip S, Maydeo A, Doctor N. Ruptured subcapsular giant haematoma of the spleen--a rare complication of acute pancreatitis. *Trop Gastroenterol* 2010; **31**: 123-124 [PMID: 20862992]
- 6 **Mujtaba G**, Josmi J, Arya M, Anand S. Spontaneous splenic rupture: a rare complication of acute pancreatitis in a patient with Crohn's disease. *Case Rep Gastroenterol* 2011; **5**: 179-182 [PMID: 21552441]
- 7 **Lankisch PG**. The spleen in inflammatory pancreatic disease. *Gastroenterology* 1990; **98**: 509-516 [PMID: 2403954]
- 8 **Heider R**, Behrns KE. Pancreatic pseudocysts complicated by splenic parenchymal involvement: results of operative and percutaneous management. *Pancreas* 2001; **23**: 20-25 [PMID: 11451143]
- 9 **Mortel  KJ**, Mergo PJ, Taylor HM, Ernst MD, Ros PR. Splenic and perisplenic involvement in acute pancreatitis: determination of prevalence and morphologic helical CT features. *J Comput Assist Tomogr* 2001; **25**: 50-54 [PMID: 11176293]
- 10 **Werner J**, Hartwig W, Hackert T, B chler MW. Surgery in the treatment of acute pancreatitis--open pancreatic necrosectomy. *Scand J Surg* 2005; **94**: 130-134 [PMID: 16111095]

**P- Reviewer:** Kamer E, Poma EM, Sferra TJ  
**S- Editor:** Ji FF **L- Editor:** A **E- Editor:** Li D





Published by **Baishideng Publishing Group Inc**

8226 Regency Drive, Pleasanton, CA 94588, USA

Telephone: +1-925-223-8242

Fax: +1-925-223-8243

E-mail: [bpgoffice@wjgnet.com](mailto:bpgoffice@wjgnet.com)

Help Desk: <http://www.wjgnet.com/esps/helpdesk.aspx>

<http://www.wjgnet.com>

