

Alessandro Feola, Massimo Niola, Adelaide Conti, Paola Delbon, Vincenzo Graziano, Mariano Paternoster*, Bruno Della Pietra

Iatrogenic splenic injury: review of the literature and medico-legal issues

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Abstract: Introduction: Iatrogenic splenic injury is a recognized complication in abdominal surgery. The aim of this paper is to understand the medico-legal issues of iatrogenic splenic injuries. We performed a literature review on PubMed and Scopus using iatrogenic splenic or spleen injury and iatrogenic splenic rupture as keywords. Iatrogenic splenic injury cases were identified. Most cases were related to colonoscopy, but we also identified cases related to upper gastrointestinal procedures, colonic surgery, ERCP, left nephrectomy and/or adrenalectomy, percutaneous nephrolithotomy, vascular operations involving the abdominal aorta, gynecological operation, left lung biopsy, chest drain, very rarely spinal surgery and even cardiopulmonary resuscitation. There are several surgical procedures that can lead to a splenic injury. However, from a medico-legal point of view, it is important to assess whether the cause can be attributed to a technical error of the operator rather than being an unpredictable and unpreventable complication. It is important for the medico-legal expert to have great knowledge on iatrogenic splenic injuries because it is important to evaluate every step of the first procedure performed, how a splenic injury is produced, and whether the correct treatment for the splenic injury was administered in a judgment.

Keywords: Spleen laceration; Spleen rupture; Splenectomy; Iatrogenic splenic injury; Professional liability; Colonoscopy

1 Introduction

Iatrogenic splenic injury is a recognized complication in abdominal surgery that results in an increased risk of morbidity and mortality, increased operation time, and a longer hospitalization [1,2]. Numerous risk factors are associated with iatrogenic splenic injury, such as previous surgery adhesions, underlying pathology, morbid obesity, advanced age and location of primary incision (exposure of the left upper quadrant) [3]. It is also important to know how this type of injury is produced to evaluate medical professional liability. Therefore, in many cases, a splenectomy is required after an injury and can cause permanent impairment. The aim of this review is to evaluate cases of iatrogenic injury of the spleen and analyze the related medico-legal cases.

2 Methods

A review of the literature on iatrogenic splenic injuries was conducted. The research was performed using PubMed and Scopus with the following keywords:

- iatrogenic AND spleen OR splenic AND injuries OR injury
- iatrogenic AND splenic OR spleen AND rupture

Furthermore, scientific articles were identified using the reference lists of eligible studies or articles citing the eligible studies.

To include papers in our review, we decided to employ the subsequent criteria:

1. papers written in English;

*Corresponding author: **Mariano Paternoster**, University of Naples Federico II, Naples, Italy, E-Mail: mariano.paternoster@unina.it
Alessandro Feola, Bruno Della Pietra, Department of Experimental Medicine, Second University of Naples, Naples, Italy
Massimo Niola, Vincenzo Graziano, Department of Advanced Biomedical Sciences, University of Naples “Federico II”, Naples, Italy
Adelaide Conti, Paola Delbon, Department of Surgery, Radiology and Public Health, Public Health and Humanities Section, University of Brescia – Centre of Bioethics Research, Italy

2. full text available;
3. papers that report clinical data of the case under examination.

3 Results

We identified 55 papers reporting 88 cases according our criteria. Colonoscopy was the procedure most related to spleen injury, but cases related to upper gastrointestinal procedures, colonic surgery, ERCP, left nephrectomy and/or adrenalectomy, percutaneous nephrolithotomy, vascular operations involving abdominal aorta, gynecological operation, left lung biopsy, chest drain, very rarely spinal surgery and even cardiopulmonary resuscitation were also described. The management of splenic injury included splenectomy (n.=57) and conservative treatment (n.=30). The cases are summarized in Table 1.

4 Discussion

The spleen is situated in the left upper quadrant running along the 9th rib, and it is surrounded by a peritoneal capsule [59]. The spleen's function is not fully understood; however, it is important in circulatory filtration, immune responses, hemopoiesis, iron reutilization, and blood and immune cell reservoir function [59]. The spleen represents the largest accumulation of lymphoid tissue in the body [59]. Cassar *et al.*, defined iatrogenic splenic injury as any unintentional damage caused to the spleen by the surgeon or the assistant(s) during a surgical procedure [1]. The true incidence of iatrogenic splenic injuries is difficult to assess due to variability in reporting and documentation [1, 60]. In the literature, iatrogenic splenic injuries have been reported after various surgical procedures, such as upper gastrointestinal procedures, colonic surgery, colonoscopy, ERCP, left nephrectomy and/or adrenalectomy, percutaneous nephrolithotomy, vascular operations involving abdominal aorta, gynecological operation, left lung biopsy, chest drain and very rarely spinal surgery [4-59, 61-64]. These injuries are also described in cases of cardiopulmonary resuscitation [31, 65-67]. As noted in table 1, the procedure most related to iatrogenic splenic injury is colonoscopy; however, splenic injury is not a frequent complication of colonoscopy [34]. The risk factors for splenic injury during colonoscopy are categorized as patient and operator dependent. Patient associated risk factors include splenomegaly, adhesions between spleen and colon from prior surgery, neoplasm,

and inflammation, such as diverticular disease, pancreatitis, inflammatory bowel disease, endometriosis, and infection (malaria, typhoid fever, Epstein-Barr virus-induced mononucleosis, anticoagulation) [68]. Operator-dependent risk factors include supine position, inexperienced operator, biopsy polypectomy, excess tractions, direct injury, and multiple previous colonoscopies [68]. In addition, various maneuvers during colonoscopy, such as hooking the splenic flexure to straighten left colon, applying external pressure on the left hypochondrium, slide by advancement and alpha maneuver, are risk factors for splenic injury [19, 68]. The significance of splenic injury and subsequent splenectomy during colon surgery has been well documented [69]. Merchea *et al.* performed a study on 13,897 colectomies and reported a total of 71 splenic injuries (0.42%), of which 44 (76%) required a splenectomy [60]. Masoomi *et al.*, analyzed data from 975,825 individuals who underwent colorectal resection during the period of 2006 to 2008 and found that the rate of splenic injury was 0.96%, of which 84.75 were treated with splenectomy [2]. These iatrogenic injuries account for approximately 20% of all spleen procedures performed in the US [70]. According to Masoomi *et al.*, the most common procedure associated with splenic injury is transverse colectomy [2]. During colectomy, the majority of splenic injuries are capsular tears due to traction [60]. An important risk factor is previous abdominal operations, which contribute to the presence of adhesions in the splenic region [60]. Finally, it must be highlighted that colonic surgery performed laparoscopically is less associated with splenic injury compared with laparothomic procedures [2, 71, 72]. Cases of splenic injury have also been described in upper gastrointestinal surgery [56]. Splenic injury is also a rare complication of ERCP [12,38,50]. The mechanism by which the injury is produced remains unclear, but it postulated that bowing of the endoscope in the long position with torsion on the greater curvature of the stomach plays a key role [12, 16]. In particular, this maneuver may cause splenic capsular tears or vascular avulsion by traction on the short gastric vessels [22,38]. In addition, increased manipulation resulting from difficulty accessing the ducts and a prolonged procedure resulting from activities, such as obtaining biopsies or brushings, are also potentially associated with increased risk of injury [16]. Furthermore, positioning a chest drain can produce splenic injury. This complication is typically related to a malpositioning of the intercostal chest drain [73] or percutaneous procedures, such as lung biopsy or nephrolithotomy. Kong *et al.* evaluated visceral injuries produced by misplaced intercostal chest drains and found that 6 out of 58 patients experienced a splenic injury (3 isolated splenic

Table 1: Cases selected from the literature

Author	Publication Year	Patient (age; sex)	Procedure	Spleen Injury	Treatment
Zappa et al. [4]	2016	73 M	colonoscopy	grade III subcapsular hematoma	splenectomy
Lahat et al. [5]	2016	61 F	colonoscopy	splenic injury grade III	splenectomy
Lahat et al. [5]	2016	68 F	colonoscopy	splenic injury grade II	conservative
Lahat et al. [5]	2016	85 M	colonoscopy	splenic injury grade III	splenectomy
Lahat et al. [5]	2016	54 F	colonoscopy	splenic injury grade III	splenectomy
Lahat et al. [5]	2016	65 F	colonoscopy	splenic injury grade III	splenectomy
Lahat et al. [5]	2016	61 F	colonoscopy	splenic injury grade II	conservative
Bogner et al. [6]	2015	38 M	thoracoscopic corpectomy and replacement of the vertebral body	rupture	splenectomy
Giri et al. [7]	2015	67 M	open left nephrectomy	2 cm long, 1 cm deep splenic tear	conservative
Giri et al. [7]	2015	58 M	open left nephrectomy	3 cm long, 1 cm deep splenic tear	conservative
Giri et al. [7]	2015	54 M	open left nephrectomy	3 cm long, 1 cm deep splenic tear	splenectomy
Giri et al. [7]	2015	64 F	open left nephrectomy	2 cm long, 2 cm deep splenic tear	conservative
Ridd et al. [8]	2015	69 F	colonoscopy	large hematoma surrounding the spleen with capsular avulsion	splenectomy
Mulkerin et al. [9]	2015	64 M	colonoscopy	large subcapsular hematoma	splenectomy
Voore [10]	2015	52 F	colonoscopy	hematoma	splenectomy
Angeli et al. [11]	2015	63 F	colonoscopy	Laceration and decapsulation of the upper pole	splenectomy
Angeli et al. [11]	2015	62 F	colonoscopy	subcapsular hematoma	conservative
Grammatopoulos et al. [12]	2014	64 M	ERCP	rupture at the hilum	splenectomy
Sevinc et al. [13]	2014	57 M	colonoscopy	rupture	splenectomy
Brennan et al. [14]	2014	75 F	colonoscopy	lower pole splenic laceration	conservative
Gremida et al. [15]	2014	74 M	colonoscopy and polypectomy	sub-capsular splenic hematoma	splenectomy
Weaver et al. [16]	2013	66 M	ERCP	rupture	splenectomy
Chow et al. [17]	2013	84 F	colonoscopy	grade III or IV splenic laceration	conservative
Malik et al. [18]	2013	61 M	colonoscopy	Grade III splenic lesion	splenectomy
Malik et al. [18]	2013	46 F	colonoscopy	Grade III splenic lesion	splenectomy
Zandonà et al. [19]	2012	80 M	colonoscopy follow-up and biopsies for colorectal neoplastic disease	rupture of the splenic capsule	splenectomy
Asnis et al. [20]	2012	28 M	elective splenectomy for massive enlarged spleen	following incision, huge abdominal bleeding due to splenic rupture	splenectomy
Elessawy et al. [21]	2012	40 F	laparoscopic excision of uterine myoma	superficial tear of the capsule	splenectomy
Gaffney et al. [22]	2012	48 M	ERCP	Laceration with subcapsular hematoma	conservative

Table 1 continued: Cases selected from the literature

Henneman et al. [23]	2012	44 F	laparoscopic Roux-en-Y gastric bypass	subcapsular splenic hemorrhage	conservative
Garancini et al. [24]	2011	77 M	colonoscopy	complete laceration of splenic capsule	splenectomy
Darragh et al. [25]	2011	58 F	chest drain for a thick walled empyema in the left lung	chest drain traversing the spleen with associated hemorrhage	conservative
Pothula et al. [26]	2010	64 M	screening colonoscopy with polypectomy	splenic laceration	splenectomy
Binning et al. [27]	2010	60 M	T12 corpectomy and fusion using a thoracoscopic approach	rupture	splenectomy
Arruabarrena et al. [28]	2010	61 M	laparoscopic left nephrectomy	rupture	splenectomy
Murariu et al. [29]	2010	55 F	colonoscopy	rupture	splenectomy
Desai et al. [30]	2010	62 M	percutaneous nephrolithotomy	Nephrostomy tube through the spleen	conservative
Wind et al. [31]	2009	49 M	mechanical cardiopulmonary resuscitation	rupture found at the autopsy	none
Kiosoglous et al. [32]	2009	47 F	colonoscopy	splenic tear	splenectomy
de Vries et al. [33]	2009	81 M	colonoscopy	large hematoma in the spleen	splenic embolization
de Vries et al. [33]	2009	66 F	colonoscopy	hemorrhage	splenectomy
Kamath et al. [34]	2009	70 M	colonoscopy	splenic tear	splenectomy
Kamath et al. [34]	2009	56 M	colonoscopy	splenic laceration	splenectomy
Kamath et al. [34]	2009	46 F	colonoscopy	splenic injury with hemoperitoneum	splenectomy
Kamath et al. [34]	2009	40 F	colonoscopy	splenic injury with hemoperitoneum	splenectomy
Kamath et al. [34]	2009	45 F	colonoscopy	splenic injury	splenectomy
Kamath et al. [34]	2009	64 F	colonoscopy	splenic injury	splenectomy
Kamath et al. [34]	2009	59 F	colonoscopy	splenic injury	splenectomy
Kelly [35]	2009	73 M	chest drain for a left-sided empyema thoracis	bleeding point in the spleen with surrounding hematoma	conservative
Skipworth et al. [36]	2009	71 F	colonoscopy	shattered spleen	splenectomy
Petersen et al. [37]	2008	65 M	colonoscopy	laceration	splenectomy
Petersen et al. [37]	2008	70 F	colonoscopy	laceration	splenectomy
Petersen et al. [37]	2008	38 M	sigmoidoscopy	hilar laceration	splenectomy
Petersen et al. [37]	2008	72 F	colonoscopy	laceration	splenectomy
Petersen et al. [37]	2008	66 F	colonoscopy	capsule avulsion	splenectomy
Petersen et al. [37]	2008	80 F	colonoscopy	capsule avulsion	splenectomy
Petersen et al. [37]	2008	68 F	colonoscopy	capsule avulsion and tear in the lower pole	splenectomy
Petersen et al. [37]	2008	67 F	colonoscopy	capsule avulsion and tear	splenectomy
Cho et al. [38]	2008	63 F	ERCP	Laceration	splenectomy
Khan et al. [39]	2008	48 M	left lung biopsy	ruptured subcapsular splenic hematoma	unavailable

Table 1 continued: Cases selected from the literature

Gayer et al. [40]	2008	81 F	left hemicolectomy and omentectomy	one infarct containing tiny air bubbles	conservative
Gayer et al. [40]	2008	66 F	total colectomy	a subcapsular collection	conservative
Gayer et al. [40]	2008	81 F	left hemicolectomy	two infarcts	conservative
Gayer et al. [40]	2008	70 M	anterior resection and subsequent repair of an anastomotic leak	a subcapsular collection	conservative
Gayer et al. [40]	2008	67 M	abdominoperineal resection of colon and colostomy	one infarct	conservative
Gayer et al. [40]	2008	21 F	left adrenalectomy and nephrectomy	one infarct	conservative
Gayer et al. [40]	2008	57 F	bilateral salpingoophorectomy and omentectomy	laceration	conservative
Heyworth et al. [41]	2008	44 F	thoracolumbar spinal fusion	intracapsular hematoma with extracapsular extension	splenectomy
Duarte [42]	2008	50 F	colonoscopy	4 × 10 cm perisplenic hematoma	conservative
Lalor et al. [43]	2007	82 F	colonoscopy	rupture	splenectomy
Di Lecce et al. [44]	2007	64 M	colonoscopy	rupture	splenectomy
Sin et al. [45]	2007	52 M	anterior L1-L2 corpectomy and fusion of osteomyelitis of the lumbar spine	laceration	splenectomy
Carey et al. [46]	2006	52 M	percutaneous nephrostolithotomy	transsplenic percutaneous renal access	conservative
Prowda et al. [47]	2005	48 F	colonoscopy	subcapsular and perisplenic hematoma	conservative
Prowda et al. [47]	2005	85 F	colonoscopy	subcapsular and perisplenic hematoma	conservative
Goitein et al. [48]	2004	39 F	colonoscopy	capsular tear	splenectomy
Rinzivillo et al. [49]	2003	71 M	colonoscopy	approximate 6-cm tear towards the diaphragmatic face	splenectomy
Kingsley et al. [50]	2001	54 F	ERCP	rupture	splenectomy
Chang et al. [51]	2000	31 F	laparoscopic salpingoplasty to correct bilateral hydrosalpinges and reform the fimbriated tubal ends	a small tear (3 cm long and 1 cm deep) with active bleeding in the inferior splenic tail	conservative
Tse et al. [52]	1999	67 F	colonoscopy	Capsular lesion	splenectomy
Santiago et al. [53]	1998	20 F	percutaneous renal surgery	splenic hematoma	conservative
Ahmed et al. [54]	1996	72 F	colonoscopy	rupture	splenectomy
Levine et al. [55]	1987	62 F	colonoscopy	subcapsular and perisplenic hematomas and splenic laceration	splenectomy
Sagar et al. [56]	1987	74 M	benign esophageal stricture negotiated with a fine guide wire and dilated using a Celestin dilatator	splenic hematoma	conservative
Castelli [57]	1986	71 F	colonoscopy	rupture	splenectomy
Mearns et al. [58]	1973	50 F	pleural biopsy	subcapsular hematoma with rupture near the upper pole and 1 to 4 cm track passing into the pulp	splenectomy

Table 1 continued: Cases selected from the literature

Mearns <i>et al.</i> [58]	1973	33 F	chest drain to aspire a pleural effusion	subcapsular hematoma	conservative
Mearns <i>et al.</i> [58]	1973	66 F	chest aspiration in the seventh left intercostal space in the mid-axillary line	large subcapsular hematoma extending over the entire convex aspect of the surface and an enveloping perisplenic hematoma	splenectomy

injuries and 3 combined splenic and diaphragmatic injuries) [73]. Splenic injuries during left nephrectomy are also reported in literature. In 1996, Cooper *et al.* reported that 4.3% of left nephrectomies resulted in splenectomy [74]. In more recent papers, the rate was between 4.2% and 5.13% [7, 75]. In the case of thoracoscopic spinal surgery, the spleen can be vulnerable to iatrogenic injury due to its proximity to the thoracolumbar junction [6]. According to the American Association for the Surgery of Trauma (AAST), splenic injuries are classified as grade I) subcapsular hematoma <10% of surface area, capsular laceration <1 cm depth; grade II) subcapsular hematoma 10-50% of surface area; intraparenchymal hematoma <5 cm in diameter, laceration 1-3 cm depth not involving trabecular vessels; grade III) subcapsular hematoma >50% of surface area or expanding, intraparenchymal hematoma >5 cm or expanding, laceration >3 cm depth or involving trabecular vessels, ruptured subcapsular or parenchymal hematoma; grade IV) laceration involving segmental or hilar vessels with major devascularization (>25% of spleen); grade V) shattered spleen, hilar vascular injury with devascularized spleen [76]. The management of an iatrogenic splenic injury can be conservative or a splenectomy can be performed. The decision to attempt splenic salvage depends on the severity of the injury, the patient's hemodynamic stability, and the surgeon's experience [3]. The techniques used in conservative treatment include splenorrhaphy, topical hemostasis, suture repair, mesh repair and segmental resection [3]. Conservative management during laparoscopy can occasionally be arduous; therefore, recent advancements in surgical hemostatic agents have provided beneficial therapeutic alternatives [77]. In addition, radiofrequency fulguration has been used to achieve hemostasis to the spleen [78]. When it is not possible to salvage the spleen, a splenectomy must be performed. Splenectomy can be performed using either an open or laparoscopic method [79]. In many cases, as reported in table 1, a splenectomy is required. As described by Falsetto *et al.*, splenectomy has its own early complications, such as 1) acute gastric dilatation, collapse of the left lung base and thromboembolic events; 2) blood loss requiring transfusions at an increased rate compared with

patients who did not have a splenectomy; 3) infections [80]. After the surgical procedure, it should be noted that splenectomized patients are more susceptible to infections [postsplenectomy overwhelming infection (OPSI)] [81]. Finally, there are several surgical procedures that can lead to a splenic lesion; however, from a medico-legal point of view, it is important to assess whether the cause can be attributed to a technical error of the operator rather than an unpredictable and unpreventable complication of a particular surgical procedure. These considerations are important in the management of litigation for an iatrogenic splenic injury. To reduce claims, it is very important to correctly inform the patient of the risk of a splenic injury during a procedure and to describe every maneuver in the operation report.

5 Conclusions

Colonoscopy is the procedure most often associated with these injuries. However, these injuries may be observed in cases of upper gastrointestinal procedures, colonic surgery, ERCP, left nephrectomy and/or adrenalectomy, percutaneous nephrolithotomy, vascular operations involving the abdominal aorta, gynecological operation, left lung biopsy, chest drain, very rarely spinal surgery and even cardiopulmonary resuscitation. From a medico-legal point of view, iatrogenic splenic injury can represent a source of litigation. In the assessment of the possible liability of the physician, it is critical to evaluate the eligibility for the first intervention, the clinical status and patient characteristics before the intervention, and the technical execution of the procedure. Finally, in cases where a splenic injury has been determined, the indication for splenectomy or conservative treatment must be assessed because the treatment itself can determine some functional consequences for the life of the subject in addition to the risks and complications related with the splenectomy intervention itself.

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