World J Surg (2008) 32:2730–2735
DOI 10.1007/s00268-008-9733-3

World Journal of Surgery

Twenty Years of Splenic Preservation in Trauma: Lower Early Infection Rate Than in Splenectomy

Jean-Marc Gauer · Susanne Gerber-Paulet · Christian Seiler · Walter Paul Schweizer

Published online: 4 October 2008

Abstract
Background Retrospective studies concerning the operative preservation and nonoperative management of splenic injuries in patients with splenic trauma have been published; however, few studies have analyzed prospectively the results and early complication rates of a defined management in splenic injury.
Methods From 1986 to 2006, adult patients with blunt splenic injuries were evaluated prospectively with the intent of splenic preservation. Hemodynamically unstable patients underwent laparotomy. Stable patients were treated conservatively regardless of the grade of splenic injury determined by ultrasound and/or CT scan.
Results During a 20-year period, 155 patients were prospectively evaluated. In 98 patients (63%), the spleen could be preserved by nonoperative (64 patients, 65%) or operative (34 patients, 35%) treatment and 57 patients (37%) needed splenectomy. There were no differences in age, sex, or trauma score between the groups, but a higher early infection rate in patients with splenectomy compared with patients with splenic preservation ($p < 0.005$) was observed, even if the patients were matched with respect to multiple trauma using the Injury Severity Score ($p < 0.01$).
Conclusions Splenic preservation in patients with blunt splenic injury by operative or nonoperative treatment leads to lower early infection rates in adults and, therefore, should be advocated.

J.-M. Gauer · S. Gerber-Paulet · W. P. Schweizer (✉)
Department of Surgery, Kantonsspital, 8208 Schaffhausen, Switzerland
e-mail: walter.schweizer@kssh.ch

C. Seiler
Department of Visceral and Transplantation Surgery, Inselspital, University of Berne, 3010 Berne, Switzerland

Introduction

Overwhelming postsplenectomy sepsis (OPSI) was recognized in 1952 [1], followed by reports of higher infection rates after splenectomy in children and adults [2, 3], which led to attempts of splenic autotransplantation [1–9] and splenic preservation in situ [10–30]. Autotransplantation has been shown to be of little value experimentally [31, 32] as well as clinically [33–37]. Organ preservation in situ is increasingly advocated and seems to be safe [38, 39]. There have been reports of partial splenic resection after trauma [26, 40–42]. With improved diagnostic methods and close follow-up under intensive care conditions, nonoperative treatment has proven to be successful in an increasing number of children and adults [13–30, 38, 43–47]. In our study, the different diagnostic and therapeutic regimens after splenic injury were evaluated prospectively and the early complication rates were compared.

Patients and methods

From 1986 to 2006, patients with blunt splenic trauma admitted to the Department of Visceral and Transplantation Surgery at the Inselspital Bern (between 1986–1995) and the Department of Surgery Kantonsspital Schaffhausen (between 1996–2002) under supervision of the same senior surgeon (WS) were prospectively evaluated with the intent of splenic salvage. Hemodynamically unstable patients underwent immediate laparotomy after appropriate resuscitation. Splenic repair by splenorrhaphy or partial splenectomy was always attempted. Criteria for nonoperative treatment included a Shock-Index of <1.0 (pulse rate/systolic blood pressure) on admission and an initial stable phase of 2 hours (total volume of infusion <2000 ml

electrolyte solution and/or 2 units of packed red cells (the latter were more restrictively used in the later period of the study)). During these first 2 hours, accurate assessment of the severity of the splenic injury and of associated injuries was performed by ultrasound and/or CT scan. Peritoneal lavage was used in the early years for patients who needed surgery because of extra-abdominal injuries but was lately mostly abandoned and replaced by immediate CT scan. It also was used in few early cases where ultrasound was not immediately available for practical or logistical reasons. According to the ultrasound and CT-scan examinations and/or the intraoperative findings, the splenic injury was graded using the splenic injury scale with five grades (Table 1), according to the AIS 90–97 grading. Multiple trauma was classified with the Injury Severity Score (ISS) [48, 49], also according to the AIS 90–97 grading. AIS and ISS coding was all by the senior author (WS).

The surgical technique of splenic preservation was described in a technical protocol [50] and recorded in a videotape [51]. The crucial steps of the technique include the immediate dissection and delivery of the spleen from its subdiaphragmatic position as well as the avoidance of additional iatrogenic injuries, which can easily occur in an emergency situation. The hilus is then clamped with a noncrushing vascular or intestinal clamp, thus avoiding excessive blood loss during the repair. Depending on the grade of the injury, different methods for splenic repair were used. Means to prevent sutures cutting through the tissue (absorbable collagen platelets, absorbable gauze, Teflon strips) and a variety of means to achieve hemostasis (Argon beamer, infrared photocoagulation, hemostatic material, and supportive meshes, such as Vicryl meshes) were used, adapting the technique to the anatomical pattern of the various types of trauma [52, 53].

Antibiotics (Cefazoline 2 g, i.v.) were routinely given as a single-shot prophylaxis immediately before any surgery. In patients with splenectomy, antibiotics were continued for 3 to 5 days (Cefazoline 1 g, q.i.d.) followed by a single dose of 2,400,000 IU of Benzathine-Benzylpenicilline i.m. and a polyvalent pneumococcus vaccine on the tenth postoperative day. In all cases, additional antibiotic therapy was given only for proven infections according to the antibiogramm. All patients were carefully monitored for early infectious complications by clinical assessment, laboratory tests, and corresponding radiological findings. Infections with a pathognomonic clinical picture and corresponding laboratory and/or radiological findings that were confirmed by a positive bacteriological culture from a sample of sputum, blood, urine, stool, or liquor were all regarded as infectious complications. Identical bacteriological surveillance was performed in all groups. For statistical evaluation, we used the χ^2-homogenity test.

Table 1 Grading of splenic injuries

Grade	Finding
I	Minimal capsular lesion, without parenchymal lesion
II	Small parenchymal lesion
III	Considerable parenchymal lesion, but no lesion of the hilus
IV	Localized fragmentation, central parenchymal lesion
V	Total fragmentation, hilar lesion

Results

For the 20-year period of the study, 155 patients with splenic injury due to blunt abdominal trauma were evaluated prospectively (Fig. 1); 115 were men with a mean age of 34 (range, 14–85) years, and 40 were women with a mean age of 35 (range, 12–79) years. 69 patients (44.5%) were assigned to a nonoperative management and 86 patients (55.5%) required surgery.

Of these 86 patients, 55 were splenectomized at the first operation: 4 of them with splenectomy during the same operation after a first attempt of splenic repair. Two of these patients were under anticoagulation therapy because of other medical problems and had persistent bleeding during the procedure. In the other two cases, a hypoperfusion of the residual tissue was observed and splenic preservation had to be abandoned. Secondary splenectomy because of delayed bleeding after an initial conservative treatment was performed at days 2 and 8, respectively, in two further patients, both of whom were under anticoagulation therapy before admission to the hospital. The overall rate of total splenectomy was 57.

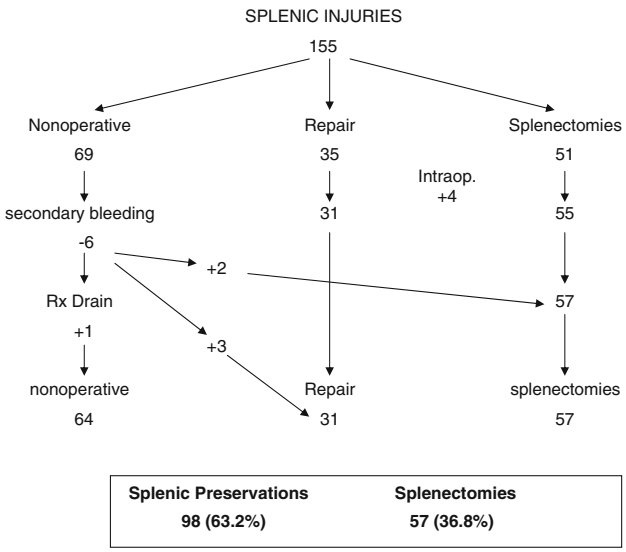

Fig. 1 Overview of primary and secondary treatment of patients with splenic injuries

In 35 patients, a primary operative splenic repair was attempted. In four patients, the spleen proved not to be preservable during surgery and splenectomy had to be performed primarily. In 15 cases, hemostatic procedures alone were successful. In 11 cases Vicryl mesh was applied, and in 5 patients a partial splenic resection was performed.

69 patients were initially assigned to nonoperative management, which was successful in 64 patients. Five patients required delayed surgery in the course of conservative treatment: one patient needed partial and two patients needed total resection of the spleen due to secondary bleeding after 7, 2, and 8 days of conservative treatment respectively. Both of the total splenectomy cases were anticoagulated for medical reasons (pulmonary embolism in past medical history). These three patients who underwent surgery after a first attempt of nonoperative treatment were more than 40 years old. The other two patients both became unstable within the first 48 hours after admission. In both cases, hemostasis could successfully be achieved by using Vicryl mesh without resection of any splenic tissue. Both of them were younger patients (35 and 17 years, respectively).

One patient developed an increasing hemoperitoneum, but the nonoperative treatment could be continued. The huge persistent hematoma was drained after 21 days with a pigtail catheter, which was placed under ultrasound guidance.

The death rate in the 57 patients with splenectomy was 10.5% (6/57 patients). Two died as a result of cerebral injuries, two because of acute respiratory distress syndrome (ARDS), one because of severe blood loss because of additional pelvic and abdominal injuries, and one due to an anaphylactic reaction to a plasma expander. The death rate in the 98 patients with operative or conservative splenic preservation was 3.1% (3/98 patients): 1 patient died as a result of cerebral injury, 1 as a result of ARDS, and 1 as a result of pulmonary embolism.

The following complications related to surgery occurred: 4 of the 57 patients with splenectomy had a postoperative secondary bleeding. Two of them had a diffuse bleeding from the splenic subdiaphragmatic cavity; in the other two cases there was continuous bleeding from the short gastric vessels. In three cases surgical reintervention was necessary, and in one case a radiologically guided percutaneous drainage of the liquefied hematoma was performed after 21 days. Two patients developed deep vein thrombosis, and three patients developed a pancreatic fistula, which could be treated conservatively. In the splenic repair group, only one patient suffered a complication related to surgery. He developed a pleural effusion, which needed to be drained percutaneously.

Three patients who required full or partial resection of splenic tissue for secondary bleeding were more than 40 years old, whereas the two patients with splenorrhaphy were only 35 and 17 years old respectively, and the patient with the radiologically guided drainage was 20 years old.

Early infectious complications occurred as follows (Fig. 2; Table 2): in the nonoperative group, in 3 of 64 patients (4.7%): 2 developed pneumonia, and 1 patient had urinary tract infection. In the splenic repair group, the early infection rate was 14.7% (5/34 patients): three pneumonias, one urinary tract infection, and one bacterial meningitis. In the splenectomy group, we found an early infection rate of 49.1% (28/57 patients): 19 pneumonias, 3 sepsis of unknown origin (UO) but with positive bacterial blood culture, 3 wound infections, 2 sinusitis, and 1 subphrenic abscess.

These differences are statistically significant for the splenectomy group vs. the conservative group ($p < 0.001$) as well as for the splenectomy group vs. the splenic repair group ($p < 0.03$). It is interesting to mention that the mean ISS in the splenic repair group was 33 compared to 31 in the splenectomy group and equal regarding the AIS distribution between the different areas (comparing chest, abdominal, and head injuries); these differences were not significant. The importance of the difference in infectious complications is further emphasized by the fact that

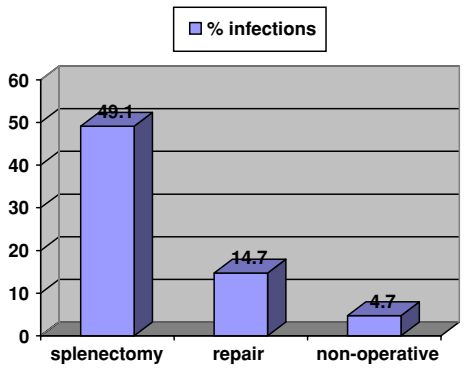

Fig. 2 Frequency of infectious complications in patients with splenectomy, splenic repair, and nonoperative treatment

Table 2 Kind of infections

Infection site	Splenectomy (28/57; 49.1%)	Repair (5/34; 14.7%)	Nonoperative (3/64; 4.7%)
Pneumonia	19	3	2
Urinary tract infection		1	1
Wound infection	3		
Sepsis of unknown origin	3		
Bacterial meningitis		1	
Sinusitis	2		
Subphrenic abscess	1		

patients with infections after splenectomy had a lower ISS (38 points) than patients with infections after splenic repair (46 points). The difference of the early infection rate of 49.1% in the splenectomy group (28/57 patients) compared with the 8.2% in the splenic preservation group (8/98 patients) is statistically highly significant ($p < 0.001$) even if patients are matched to identical ISS scoring ($p < 0.01$).

Discussion

During the observation period of our prospective study, we could preserve an increasing number of spleens in mostly polytraumatized patients (Fig. 3). The increasing preservation rate from 51% within the first 5 years of the observation period to 93% during the last 10 years respectively reflects the learning curve and increasing experience in the handling of patients with splenic injuries, especially those with splenic injuries of grade III and IV and stable hemodynamics, resulting in an improvement and therefore a higher success rate of mainly conservative treatment. This also reflects the significant improvement of the diagnostic and therapeutic means during the examined time period.

In unstable patients, operative management is mandatory, but whenever possible, operation with splenic preservation should be achieved. Partial resection can be attempted in cases in which the injury is limited to the lower pole of the spleen [40]. Due to the more exposed position of the lower pole at the lower margin of the rib cage, we now believe that in most splenic injuries at least the upper part of the organ can be preserved. This part can be supplied only by the short gastric vessels if the hilus has to be sacrificed. Moreover, in approximately 60% of patients an upper pole artery exists, which makes this kind of partial splenic preservation technically easier [41, 54].

Multiple reports suggest that splenic preservation is a safe technique [10–29, 31, 52], and we more than agree with these statements. There are not more bleeding complications in the follow-up than after splenectomy [11, 14, 20, 31]. However, one has to be aware of the small but

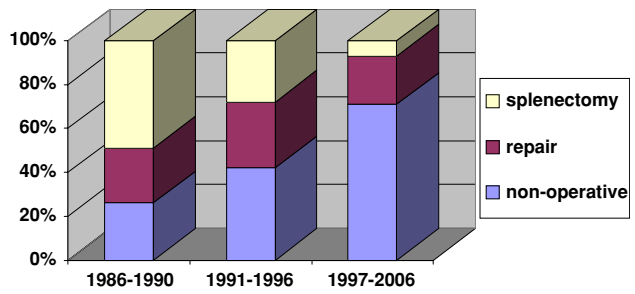

Fig. 3 Increase of nonoperative management over time

significant number of patients who develop secondary bleeding after initially conservative treatment attempts. We had 6 of 69 patients with this problem: 2 required a total splenectomy, 1 a partial splenectomy, and 2 a splenorrhaphy with a Vicryl mesh. In one patient, the conservative treatment could be continued with a later radiologically guided drainage of the hematoma.

There has been some discussion about whether older patients should be operated on more generously [20, 30, 31, 45, 46, 52, 55–58]. Older patients may profit from initial conservative management if they qualify for the above-mentioned criteria, but one has to be aware of the general health state of the individual. Older patients with severe medical conditions or even anticoagulation therapy may profit from an earlier operative intervention, even if still hemodynamically stable.

More than 90% of secondary splenic ruptures occur within 10 days after the initial trauma. Secondary ruptures after more than 2 weeks posttraumatically are a rare exception [14]. Therefore, we treat our patients conservatively in the hospital for at least 10 days for close observation. Although radiological imaging is of limited value to initially determine which patients require surgery and which can be treated with nonoperative management [57, 59, 60], all of our conservatively treated patients receive follow-up ultrasound and/or CT scan before discharge. We consider this important as a baseline study for follow-up of the amount of residual intra-abdominal fluid and consolidation of the splenic laceration. If there is any doubt about a persisting or even increasing fluid collection intra-abdominally, the patient is kept in the hospital, and when clinically stable, another study is performed after a few more days of observation.

All patients treated nonoperatively are advised not to perform any sports for at least 2 to 3 months and to further avoid contact sports for another 3 months. They are informed to present at the hospital immediately when experiencing sudden abdominal pain. This information is given to the patients and the relatives and general practitioners. As a general rule, the follow-up of these patients is done by their GP. However, if there is any doubt about the outcome, we follow-up the patients in our clinic, often with further imaging studies. In all patients with partial splenectomy, a scintigraphy with labeled old erythrocytes was performed routinely 6 months postoperatively to get a semiquantitative measurement of the residual splenic function. All of these examinations showed a completely normal splenic reticuloendothelial function after 6 months.

Our series show a significantly higher rate of early posttraumatic infections in patients treated with total splenectomy compared with patients treated with nonoperative and operative splenic preservation. This significance (between $p < 0.001$ and $p < 0.03$) persisted even when

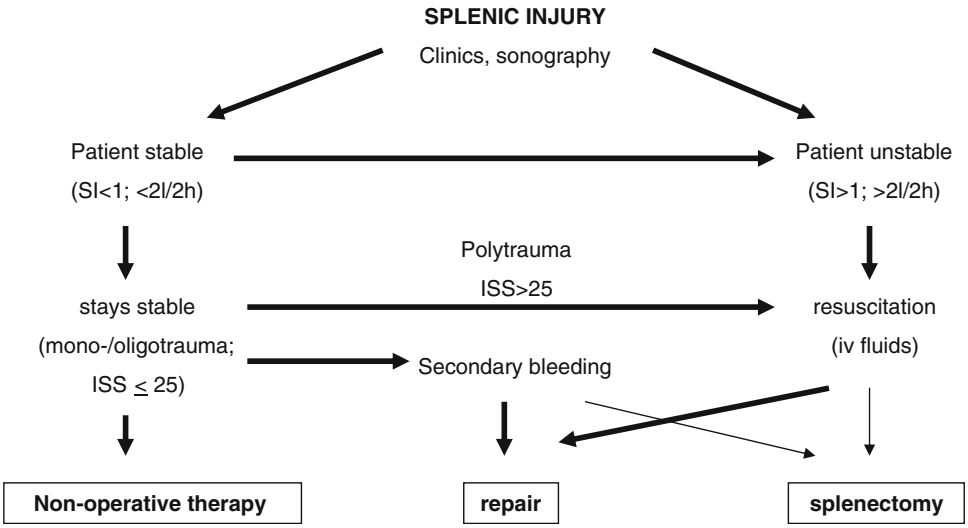

Fig. 4 Algorithm for splenic injuries

matching the different patient groups for severity of splenic injury and ISS respectively. The difference is clinically and statistically significant because all infections were proven bacteriologically. It also is an interesting fact that all the infections were caused by encapsulated organisms [28]. It seems likely that these also contribute to the late infections in splenectomized patients [20, 21, 60].

We are aware of the fact that in these mostly polytraumatized patients, an exact prospective, randomized comparison of the different individual patients is ethically not justified and therefore an evidence-based study grade I will never be possible.

Conclusions

According to the data evaluated in our study and the literature reviewed that regards early [2, 31, 52, 61–63] and late [1–4, 29, 33, 34, 52, 64] complications after splenectomy, we strongly advocate that the treatment of splenic trauma consists whenever possible in splenic preservation. Hemodynamically unstable and/or polytraumatized patients will benefit from an improved immunity if treated with operative splenic preservation instead of total splenectomy. The slightly longer operating time can be neglected [31]. Nonoperative treatment should be chosen whenever possible, especially in younger patients with mono- or oligotrauma being hemodynamically stable, but also in older patients with a good general health before the trauma (Fig. 4).

Compared with data from the literature, we had similar percentages of conservative approach, splenic repair, and splenectomy [17, 39, 44, 64]. In adult patients, data about conservative management of splenic injuries have a wide range, varying from 30–85% [17, 20–22, 38, 39, 43, 44, 46, 47, 52, 55, 65], whereas in children this percentage increases up to 95% [23, 24, 65]. We could show that full or partial preservation of the spleen should, in experienced hands, be possible in up to 90% or more of splenic injury in adults.

References

1. King H, Shumacker HP (1952) Spleen studies I. Susceptibility to infection after splenectomy in infancy. Ann Surg 136:239–249
2. O'Neal BJ, McDonald JC (1981) The risk of sepsis in asplenic adults. Ann Surg 194:775–8
3. Pimpl W, Dapunt O, Kaindl H et al (1989) Incidence of septic and thromboembolic-related deaths after splenectomy in adults. Br J Surg 76:517–521
4. Robinette CD, Fraumeni JF (1977) Splenectomy and subsequent mortality in veterans of the 1939–1945 war. Lancet 2:127–9
5. Cooney DR, Swanson SE, Dearth JC et al (1979) Splenic autotransplantation in prevention of overwhelming postsplenectomy infection. J Pediatr Surg 14:336–342
6. Vega A, Howell C, Krasna I et al (1981) Splenic autotransplantation: optimal functional factors. J Pediatr Surg 26:898–904
7. Hohenberger W, Haupt W, Kalden JR et al (1985) Die autologe Replantation von Milzpatikeln–ein etabliertes Verfahren? Chirurg 56:659–662
8. Pisters PWT, Pachter HL (1994) Autologous splenic transplantation for splenic trauma. Ann Surg 219:225–235
9. Martin LW (1994) Editorial: autologous splenic transplantation. Ann Surg 201:223–224
10. Feliciano DV, Bitondo CG, Mattox KL et al (1985) A four-year experience with splenectomy versus splenorraphy. Ann Surg 201:658–675
11. Giuliano AE, Lim RC (1981) Is splenic salvage safe in the traumatized patient? Arch Surg 116:651–656
12. Gosh S, Symes JM, Walsh TH (1988) Splenic repair for trauma. Br J Surg 75:1139–1140
13. Lambrecht W, Heller M (1984) Organerhaltende Therapie der kindlichen Milzruptur. Unfallchirurgie 10:66–72
14. The Splenic Injury Study Group (1987) Splenic injury: a prospective multicenter study on nonoperative and operative treatment. Br J Surg 74:310–313

15. Büyükünal C, Danismend N, Yeker D (1987) Spleen saving procedures in paediatric splenic trauma. Br J Surg 74:350–352
16. Elmore JR, Clark DE, Isler RJ et al (1989) Selective nonoperative management of blunt splenic trauma in adults. Arch Surg 124:581–585
17. Treutner KH, Bertram P, Schumpelick V (1993) Prinzipien der Milzerhaltung beim stumpfen Trauma. Chirurg 64:860–868
18. Longo WE, Baker CC, McMillen MA et al (1989) Nonoperative management of adult blunt splenic trauma: criteria for successful outcome. Ann Surg 210:626–629
19. Williams MD, Young DH, Schiller WR (1990) Trend towards nonoperative management of splenic injuries. Am J Surg 160:588–589
20. Smith JS Jr, Wengrovitz MA, DeLong BS (1992) Prospective validation of criteria, including age, for safe, nonsurgical management of the ruptured spleen. J Trauma 33:363–368
21. Oller B, Armengol M, Camps I et al (1991) Nonoperative management of splenic injuries. Am Surg 57:409–413
22. Buess E, Illi OE, Soder C et al (1992) Ruptured spleen in children: 15-year evolution in therapeutic concepts. Eur J Pediatr Surg 2:157–161
23. Lakhoo K, Bass DH, Cywes S (1991) Blunt splenic trauma in children. S Afr J Surg 29:108–109
24. Lucas CE (1991) Splenic trauma. Choice of management. Ann Surg 213:98–112
25. Witte CL, Esser MJ, Rappaport WD (1992) Updating the management of salvageable splenic injury. Ann Surg 215:261–265
26. Schweizer W, Bohlen L, Dennison A, Blumgart LH (1992) Prospective study in adults of splenic preservation after traumatic rupture. Br J Surg 79:1330–1333
27. Bjerke S, Pohlman T, Saywell RM et al (2006) Evolution, nor revolution: splenic salvage for blunt trauma in a statewide voluntary trauma-system: a 10-year experience. A J Surg 191:413–417
28. Watson GA, Rosengart MR, Zenati MS et al (2006) Nonoperative management of severe blunt splenic injury: are we getting better? J Trauma 61:1113–1119
29. Harbrecht BG, Zenati MS, Ochoa JB et al (2007) Evaluation of a 15-year experience with splenic injuries in a state trauma system. Surgery 141:229–238
30. Barone JE, Burns G, Svehlak SA et al (1999) Management of blunt splenic trauma in patients older than 55 years. J Trauma 46:87–90
31. Dürig M, Harder F (1985) Die splenektomie und ihre alternativen. In: Aktuelle Probleme in Chirurgie und Orthopädie. Hans-Huber Verlag, Bern
32. Oakes DD (1981) Splenic trauma. Curr Probl Surg 18:341–401
33. Perry JF Jr (1988) Injuries of the spleen. Curr Probl Surg 25:749–859
34. Moore GE, Stevens RE, Moore EE et al (1983) Failure of splenic implants to protect against fatal postsplenectomy infection. Am J Surg 146:413–414
35. Traub A, Giebink GS, Smith C et al (1987) Splenic reticuloendothelial function after splenectomy, spleen repair and spleen autotransplantation. N Engl J Med 317:1559–1564
36. Weber T, Hanisch E, Baum RP et al (1998) Late results of heterotopic autotransplantation of splenic tissue into the greater omentum. World J Surg 22:883–889
37. Seufert RM (1986) Transplantation of the spleen: status determination. Chirurg 57:182–188
38. Bain IM, Kirby RM (1998) 10-year experience of splenic injury: an increasing place for conservative management after blunt trauma. Injury 29:177–182
39. Pachter HL, Guth AA, Hofstetter SR et al (1998) Changing patterns in the management of splenic trauma: the impact of nonoperative management. Ann Surg 227:708–717
40. Resende V, Petroianu A (1998) Subtotal splenectomy for treatment of severe splenic injuries. J Trauma 44:933–935
41. Streicher HJ (1986) Anatomically related surgery of the spleen. Chirurg 57:177–181
42. Bisteff EL, Adkins BR (1984) Splenic trauma: a trial at selective management. Southern Med J 77:1284–1290
43. Goan Y, Huang M, Lin J (1998) Nonoperative management for extensive hepatic and splenic injuries with significant hemoperitoneum in adults. J Trauma 45:360–365
44. Peitzmann AB et al from the EAST (2000) Blunt splenic injury in adults: multi-institutional study of the Eastern Association for the Surgery of Trauma. J Trauma 49:177–189
45. Myers JG, Dent DL, Stewart RM et al (1974) Blunt splenic injuries: dedicated trauma surgeons can achieve a high rate of nonoperative success in patients of all ages. J Trauma 48: 801–806
46. Bee TK, Croce MA, Miller PR et al (2001) Failures of splenic nonoperative management: is the glass half empty or half full? J Trauma 50:230–236
47. Brasel KJ, DeLisle CM, Olson CJ et al (1998) Splenic injury: trends in evaluation and management. J Trauma 44:283–286
48. Baker SP, O'Neill B, Haddon W et al (1974) The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma 14:187–196
49. Baker SP, O'Neill B (1976) The injury severity score: an update. J Trauma 16:882–885
50. Schweizer W, Böhlen L, Gilg M, Blumgart LH (1991) Technical aspects of spleen saving therapy in splenic trauma. Helv Chir Acta 58:137–141
51. Schweizer W, Böhlen L, Gilg M, Kipfer B, Blumgart LH (1990) Splenic preservation in trauma. Videothek Swiss Surgical Society
52. Pachter HL, Grau J (2000) The current status of splenic preservation. Adv Surg 34:137–174
53. Uranus S, Mischinger HJ, Pfeifer J et al (1996) Hemostatic methods for the management of spleen and liver injuries. World J Surg 20:1107–1111
54. Roth H, Zacharious Z, Daum R (1987) Die arterielle Blutversorgung des oberen Milzpoles bei Stammarterienverschluss. Chirurg 58:828–830
55. Cocanour C, Moore FA, Ware DN et al (2000) Age should not be a consideration for nonoperative management of blunt splenic injury. J Trauma 48:606–612
56. Kluger Y, Rabau M, Rub R et al (1999) Comparative study of splenic wound healing in young and adult rats. J Trauma 47:261–264
57. Shapiro M, Krausz C, Durham RM et al (1999) Overuse of splenic scoring and computed tomographic scans. J Trauma 47:651–658
58. Tsugawa K, Koyanagi N, Hashizume M et al (2002) New insight for management of blunt splenic trauma: significant differences between young and elderly. Hepatogastroenterology 49:1144–1149
59. Becker CD, Spring P, Glättli A, Schweizer W (1994) Blunt splenic trauma in adults: can CT findings be used to determine the need for surgery? AJR Am J Roentgenol 162:343–347
60. Haan JM, Boswell S, Stein D et al (2007) Follow-up abdominal CT is not necessary in low-grade splenic injury. Am Surg 73:13–18
61. Di Cataldo A, Puleo S, Li Destri G et al (1987) Splenic trauma and overwhelming postsplenectomy infection. Br J Surg 74:350–352
62. Dürig M, Harder F (1986) Auswirkungen der Splenektomie. Chirurg 57:189–193
63. Carlin AM, Tyburski JG, Wilson RF et al (2002) Factors affecting the outcome of patients with splenic trauma. Am Surg 68:232–239
64. Green JB, Shackford SR, Sise MJ et al (1986) Late septic complications in adults following splenectomy for trauma: a prospective analysis in 144 patients. J Trauma 26:999–1004
65. Konstantakos AK, Barnoski AL, Plaisier BR et al (1999) Optimizing the management of blunt splenic injury in adults and children. Surgery 126:805–813