

# Literature review of non-operative management of patients with blunt splenic injury: impact of splenic artery embolization

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## Abstract

*Splenic injuries constitute the most common injuries accompanying blunt abdominal traumas. Non-operative treatment is currently the standard for treating hemodynamically stable patients with blunt splenic injuries. The introduction of splenic angiography has increased the possibility of non-operative treatment for patients who, in the past, would have qualified for surgery. This cohort includes mainly patients with severe splenic injuries and with active bleeding. The results have indicated that applying splenic angioembolization reduces the frequency of non-operative treatment failure, especially in severe splenic injuries; however, it is still necessary to perform prospective, randomized clinical investigations.*

**Key words:** splenic injuries, angiography, angioembolization.

## Introduction

Abdominal organ injuries are found in 20% to 30% of patients with multi-organ injuries [1, 2]. Splenic injuries constitute the most common injuries accompanying blunt abdominal traumas [3, 4]. Splenic damage represents approximately 3% of injuries found in patients after blunt injuries [5]. Blunt splenic injury has various therapeutic options depending on the patient's hemodynamic condition and the accompanying injuries of other organs. Surgery remains the gold standard for treating patients with splenic injuries with hemodynamic instability and it has constituted 31–35% [6, 7] or even up to 50% of cases [8]. Over the last few years, a distinct trend in spleen saving has been observed and increasing numbers of patients with these injuries have been treated non-operatively [9], including patients with abdominal multi-organ injuries [10]. Presently, non-operative procedures in blunt splenic traumas are also being recommended in hemody-

namically stable patients [11]; similarly, they have already been recommended for children [12, 13]. Non-operative treatment, combined with splenic artery angioembolization, is among the options for the treatment of hemodynamically stable patients, regardless of splenic injury severity [5, 14].

## Non-operative treatment

This multi-centre study enrolled more than 200 000 traumatic patients, of whom 6308 were patients with blunt splenic injuries, observed according to the changing trends in spleen injury treatment in adults [5]. It was found that the frequency of immediate operations decreased from 52% in 1993 to 39% in 1997. Simultaneously, the frequency of unsuccessful non-operative treatments decreased from 13.5% to 10.08%, proportional to the severity of spleen injury evaluated according to the American Association for the Surgery of Trauma (AAST) grading system, grade IV and V, respectively, occur-

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ring in 33.3% and 75%. It was also found that two thirds of patients in whom conservative treatment was not effective were operated on within 24 h after hospital admission, while only 13.8% and 6.9% required changes in treatment on the second and third days, respectively. The degree of splenic injury and the size of intraperitoneal hematoma were indices for non-operative treatment success. Conservative treatment was effective in 80% of patients with a small hematoma, defined as perisplenic blood, in more than 50% of patients with a medium-sized hematoma, defined as the presence of blood around the pericolon groove on one side or on both sides, and nearly one third (27.4%) of patients with large hematomas, defined as the presence of blood in the pelvis minor.

The ReCONNECT study included patients with spleen injuries of grades IV and V according to the AAST scale, finding that 42% of these patients required immediate operations, while 58% were treated conservatively at first [15]. Thirty-eight percent of patients from the second group required operations within the next few days, of whom more than two thirds required surgery within the first 24 h after admission. Operative treatment was necessary in 249 of 388 patients (64%), including 60% with grade IV and 83.5% with grade V spleen injuries. Multifactor analysis showed two independent conservative treatment failure factors: grade V according to the AAST grading system of spleen injury and cerebral trauma. Another large analysis included 23 532 patients with blunt splenic injuries, of whom 89% had initially non-operative treatment, and the success rate of these procedures was 78%. The frequency of non-operative failure was proportional to spleen injury severity, according to the AAST scale and according to the Injury Severity Score [16]. Another study found that the success rate of non-operative treatment of hemodynamically stable patients with spleen injuries was as high as 90% [17]. Many studies have attempted to establish prognostic factors for non-operative treatment failure in patients with blunt spleen injuries in stable hemodynamic conditions. The failure predictors of non-operative spleen injury treatment have included age older than 50 years old, severe spleen injury estimated according to the AAST scale, the presence of a large hematoma in the peritoneal cavity and injury severity estimated using the Injury Severity Score (ISS) [15, 17–21]. Olthof *et al.* undertook a systematic review of stud-

ies to identify prognostic factors for non-operative treatment failure of blunt spleen injuries [22]. Age  $\geq 40$  years old, severity of injury according to ISS score  $\geq 25$  and grade of spleen injury according to AAST scale  $\geq 3$  were counted among the strong predictors of conservative treatment failure. Following another analysis, the non-operative treatment failure rate was estimated to be 4–52%, with a mean of 12% [23]. This analysis consisted of 25 studies: 4 prospective and 16 retrospective. Sixteen studies of high quality were graded on the basis of the Newcastle-Ottawa Scale (NOS). Severe spleen injuries, estimated using the AAST scale with a cut-off point greater than 3 or 4, the presence of a large intraperitoneal hematoma and age older than 55 years were strongly correlated with conservative treatment failure. The analysis also included 5 studies in which spleen artery angioembolization was applied. It was found that embolization reduced the risk of conservative treatment failure (OR 0.26, 95% CI: 0.13–0.53;  $p < 0.002$ ). The authors of both analyses emphasized the lack of randomized studies in this area. Historically, splenectomy was the treatment of choice for patients with traumatic splenic injury. Over the last decade, non-operative management has become the preferred treatment for hemodynamically stable patients with blunt splenic injury. Selective non-operative management of abdominal trauma is safe and has been shown to reduce the rate of unnecessary laparotomy. The role of laparoscopy in blunt trauma has yet to be clearly defined. Laparoscopic splenectomy has become the gold standard in some hematological diseases [24–27]. However, a series of cases of blunt abdominal trauma in which laparoscopy was used as a therapeutic tool has been reported [28].

## Angiography and embolization

In 1981, Sclafani presented a series of 4 patients with splenic injuries, in whom angiography and embolization of the splenic artery were applied [29]. To date, many studies have confirmed the effectiveness of spleen artery angioembolization in hemodynamically stable patients with spleen injuries, through decreases in indices of conservative treatment failure and in the necessity of surgery, especially in cases of severe injuries [30–34]. Sabe *et al.* presented a retrospective analysis of a period of 16 years, including 815 patients treated due to blunt spleen injuries [35]. The patients were divided into 3 groups

with regard to the frequency of angioembolization application. In the first group, angioembolization was not applied as a routine procedure (1991–1998); in the second group, it was introduced and applied discretionarily (1998–2001); and in the third group, angioembolization was used as a routine procedure (2002–2007) in patients with a high risk of conservative treatment failure. As criteria for initial splenic artery embolization (SAE) treatment, the presence of extravasation or a false aneurysm on CT and grade III spleen injury with a large hematoma or grade IV injury according to the AAST scale were acknowledged. A total of 647 (79%) patients qualified for non-operative treatment. The frequency of successful conservative treatment in each group over the years increased proportionally with the frequency of SAE application. Simultaneously, a significant decrease in mortality from 5.8% in group I to 1.2% in groups II and III was found. Among 109 patients in groups II and III, who received SAE as their initial treatment, only 5 procedures (4.6%) ended in failure, while among 47 patients, who received SAE in later stages, technical failure occurred only in 1 case. Two patients required splenectomy and 3 required splenorrhaphy. The results presented by the National Trauma Registry of the American College of Surgeons regarded the influence of embolization on treatment results in patients with splenic injuries in the period 2000–2010 [36]. In a group of 1039 patients, 539 (63%) were managed non-operatively, including 104 patients who had either a proximal embolization of the splenic artery or both proximal embolization and selective distal splenic artery embolization. Angioembolization was applied in hemodynamically stable patients in whom active bleeding and splenic injury of grade IV or V were found and/or a decreasing level of hemoglobin was observed. The total index of conservative treatment failure was similar in both groups at 4%. The frequency of non-operative treatment failure was compared between the two groups, with SAE and without SAE, depending on the severity of spleen injury according to AAST. No significant differences were found in the frequency of non-operative treatment in patients with grade I–III spleen injuries. However, in grade IV and V spleen injury, the index of non-operative treatment failure was significantly higher in patients who were not treated with angioembolization, compared to those who received angioembolization: 23% vs. 3% ( $p = 0.04$ ) in grade IV; and 63% vs. 9% ( $p = 0.03$ ) in grade V. Angioembo-

lization of the splenic artery reduced the rate of conservative treatment failure from 33% to 7% ( $p = 0.009$ ). Logistic regression analysis showed that grade IV and V spleen injuries and contrast blush on CT were independent factors in non-operative treatment failure. Hemodynamically stable patients with active bleeding and injuries of grade V/VI had, respectively, 22 and 5 times greater probability of treatment failure if AE was not applied. The results of other studies have shown that the presence of contrast blush on CT was correlated with contrast extravasation on angiography and was correlated with a definitely higher risk of conservative treatment failure [36–38]. Bhullar *et al.* found a strong correlation between the presence of contrast blush on CT and active bleeding found on angiography [39]. Fifty-six percent of the patients with contrast blush found on CT had spleen injury of grades IV and V and 44% of grade I–III, according to AAST. Angiography was performed in 93% of these patients and contrast extravasation on angiography confirmed active bleeding in 98%. All these patients received splenic artery angioembolization and the applied treatment failure rate was 3% in the entire group, although it was 6% in patients with grade IV and V spleen injuries. Among the 7% of patients with contrast blush who did not undergo angiography, the non-operative treatment failure rates in the entire group were 71% and 100%, respectively, in patients with grade IV and V spleen injuries. The results of this study confirmed the statement that CT contrast blush indicated the necessity of applying angioembolization in patients with blunt spleen injuries who qualified for non-operative treatment. The authors also suggested that hemodynamically stable patients with grade IV and V spleen injuries should undergo angiography, even when no contrast blush has been found. Thirty-nine percent of patients underwent angiography, although there was no CT contrast blush, which confirmed active bleeding in 85%, and embolization appeared to be effective in all the cases. Injury of splenic vessels in the form of false aneurysms and posttraumatic arteriovenous fistulas have also been acknowledged to be factors related to a higher risk of non-operative treatment failure and these factors indicate the need for angioembolization and surgery [40, 41]. Requarth *et al.* presented a meta-analysis in which they compared the effectiveness of non-operative treatment of patients with blunt spleen injuries, regarding whether the

treatment included additional spleen artery embolization [42]. The analysis also involved 24 studies in the period from 1994 to 2009, including only 1 non-randomized cohort study (evidence level II). No randomized studies were found on this subject. The analysis included 10 157 patients treated due to splenic injury, of whom 68% were treated non-operatively. Embolization of the splenic artery was applied in only 4 studies, including a total of 393 patients. The study's analysis confirmed the clearly inverse dependence between the success of conservative treatment and the grade of spleen injury, which ranged from 4.3% (95% CI: 2.5–7.4) to 83.1% (95% CI: 54.2–96.7) for spleen injury grade I to V according to AAST. Splenic artery embolization significantly improved the results of non-operative treatment of patients with spleen injuries. The treatment failure rate in the group of patients in whom splenic artery embolization was applied, in comparison to those without embolization, was lower: 17.3% (95% CI: 7.8–34.1) vs. 43.7% (95% CI: 25.5–63.8;  $p = 0.035$ ) for grade IV; and 25% (95% CI: 8.7–53.8) vs. 83.1% (95% CI: 45.2–96.7;  $p = 0.016$ ) for grade V spleen injuries. In the group of patients in whom the splenic artery was embolized, the failure rate was 15.7% (95% CI: 10.4–23.2). The authors found that routine splenic artery embolization after blunt splenic injuries of grades IV and V could improve the results of non-operative treatment; however, this finding must be confirmed in further studies. Embolization can refer to the main trunk of the splenic artery (proximal embolization), terminal branches of the splenic artery (distal embolization) or segmental arteries (selective distal splenic artery embolization). Thus far, there has been no consensus regarding the type of embolization that provides the best results and that minimizes the number of complications. Schnüriger *et al.* presented a systematic review of studies, in which they compared the frequency of complications after proximal and distal embolization of the splenic vessels [43]. Their primary issues for analysis were bleeding, infarction and infection requiring splenectomy or splenorrhaphy, and they were defined as serious complications. If the complications did not require splenectomy, they were considered minor complications. The study included 11 studies published in 1995–2008 and involving 479 embolized patients. No randomized or cohort studies were found that compared the results of proximal versus distal embolization. The total frequency of angioem-

bolization failure was 10.2%, which was within the range of 0.0–33.3% for each study. No significant difference was found in the frequency of major complications between proximal and distal embolization. The frequency of bleeding, splenic infarction and infection after proximal embolization versus distal embolization was, respectively, 4.7% vs. 6.3%, 0.0% vs. 1.6%, and 1.9% vs. 0.0%. A trend toward a decreasing frequency of splenic infarction after proximal embolization versus distal embolization was found and this trend was, respectively, 0.0–0.5% vs. 1.6–3.8%. Only 1 patient with splenic infarction required surgery after proximal embolization with the use of a coil, which was dislocated distally. However, in the group of minor complications, significantly more frequent splenic infarction was found after distal embolization versus proximal embolization: 14.3% vs. 0.0%. In the authors' opinion, there was no explicit proof of an advantage for any of the methods, so prospective and randomized studies are still required. A comparable number of serious complications were observed that required splenectomy after proximal versus distal embolization, while minor complications, which did not require splenectomy, occurred more often after distal embolization. Delphi's study, based on the opinions of 30 international experts, attempted to reach a consensus on treating patients after blunt splenic injuries [44]. The experts agreed that observation or angioembolization could be applied in hemodynamically stable patients in cases with no bleeding or with minor intraperitoneal bleeding, defined as perisplenic blood with accompanying intraparenchymal contrast extravasation or without extravasation, regardless of the presence of an arterio-venous (AV) fistula or pseudoaneurysm. In cases of patients with severe splenic injuries and light bleeding with the presence of an AV fistula/false aneurysm, 79% of experts indicated angioembolization in cases of intraparenchymal contrast extravasation, while 71% indicated angioembolization if the extravasation occurred intraperitoneally. In cases of major intraparenchymal bleeding, defined as the presence of blood around the spleen, along the pericolonic groove and/or in the pelvis minor and intraperitoneal contrast extravasation, half of the experts would attempt angioembolization. However, if the contrast extravasation was into the parenchyma, 67% to 71% of experts would choose angioembolization. The recommended time to begin splenic artery embolization in cases

of intraparenchymal bleeding was 60 min (79% of experts), while it was 30–60 min in cases of intraperitoneal bleeding (92% of experts).

## Conclusions

Non-operative treatment is currently the standard for treating hemodynamically stable patients with blunt splenic injuries. The introduction of splenic angiography has increased the possibility of non-operative treatment for patients who, in the past, would have qualified for surgery. This cohort includes mainly patients with severe splenic injuries and with active bleeding. The results indicated that applying splenic angioembolization reduces the frequency of non-operative treatment failure, especially in severe splenic injuries; however, it is still necessary to perform prospective, randomized clinical investigations.

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