

Impact of the introduction of angioembolization on nonoperative management of blunt splenic trauma grades III and IV at Hospital João XXIII – Belo Horizonte/Brazil.

Impacto da introdução da angioembolização para o tratamento não operatório do trauma esplênico contuso grau III e IV no Hospital João XXIII, Belo Horizonte / Brasil

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ABSTRACT

Objective: Compare the success of non-operative treatment of blunt splenic injury grades III and IV, before and after the introduction of angioembolization. **Methods:** Data collected from electronic medical reports of patients presenting blunt splenic injury (BSI) grades III and IV (subcapsular hematoma was not included), according to AAST (American Association for Surgery of Trauma) classification and undergoing nonoperative management at Hospital João XXIII from January 2014 to July 2017. Data was compared to a case series of these non-operative injuries from November 2004 to December 2013 at the same institution, when angioembolization was not used. The study level of significance was 5% and outcome was failure of non-operative treatment. Analyses were made using the software R3.6.3 and MINITAB version 14. **Results:** From November/2004 to December/2013, 389 patients undergoing conservative treatment were studied, 332 (82,8%) of which presented with blunt splenic injury grade III and 67 (17,2%) had lesions grade IV, treatment failure (need for splenectomy) occurred in 36 (11%) patients with injury grade III and 22 (33%) with grade IV. From January/2014 to July/2017, when angioembolization was available, 195 patients underwent conservative treatment, 110 (56,4%) with blunt splenic injury grade III and 85 (43,6%) with grade IV. In this group, treatment failed in 4 (3,6%) with injury grade III and 6 (7%) grade IV. **Conclusion:** Nonoperative management of blunt splenic trauma associated with angioembolization is associated with a reduction in splenectomy in splenic injuries grades III and IV.

Keywords: Nonoperative management; Splenic injury; Embolization.

ABSTRACT

Objetivo: Comparar o sucesso do tratamento não operatório da lesão esplênica contusa graus III e IV, antes e após a introdução da angioembolização como método adjuvante. **Métodos:** Os dados foram coletados do prontuário eletrônico de pacientes com lesões esplênicas contusas graus III e IV (exceto hematoma subcapsular), segundo classificação da AAST (American Association for Surgery of Trauma), submetidos ao tratamento não operatório no Hospital João XXIII no período de janeiro/2014 a julho/2017. Os dados foram comparados a uma série de casos dessas mesmas lesões entre novembro/2004 e dezembro/2013 na mesma instituição, quando a angioembolização não era utilizada. O nível de significância do estudo foi 5% e seu desfecho foi a falha do tratamento não operatório. As análises foram feitas nos software R3.6.3 e MINITAB versão 14. **Resultados:** Entre novembro/2004 e dezembro/2013, foram estudados 389 pacientes em tratamento conservador, sendo 332 (82,8%) com lesão esplênica contusa grau III e 67 (17,2%) grau IV, havendo falha no tratamento (necessidade de esplenectomia) em 36 (11%) com lesão grau III e 22 (33%) com lesão grau IV. No período de janeiro/2014 a julho/2017, quando da disponibilidade da angioembolização, 195 pacientes foram submetidos a tratamento conservador, sendo 110 (56,4%) com lesão esplênica contusa grau III e 85 (43,6%) grau IV. Desses, houve falha no tratamento em 4 (3,6%) com lesão grau III e 6 (7%) com lesão grau IV. **Conclusão:** O tratamento não operatório do trauma esplênico contuso associado à angioembolização apresentou redução, com significância estatística, da necessidade de esplenectomia nas lesões esplênicas graus III e IV.

Palavras chave: Tratamento não operatório; Trauma esplênico; Embolização.

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INTRODUCTION

Trauma is one of the main causes of death in the world, and bleeding is a preventable cause.¹ The spleen is involved in almost 32% of abdominal trauma.² The spleen's role in protecting against gram-negative bacteria capsule infection is already known.³ In recent years, the substitution of the surgical treatment of blunt splenic injury (BSI) with a nonoperative management, in strictly selected cases⁴, has occurred, especially because of the long-term risks related to a splenectomy, such as post-splenectomy sepsis, although it is a rare condition.⁵

In the 1980s, angiography with splenic embolization was introduced with the aim of enhancing the spleen's preservation in victims of splenic injury.⁶

Although splenic embolization initially presented high levels of spleen preservation,⁷ subsequent research have shown controversial results.^{8,9}

Patient selection for embolization treatment is not clear in literature and is a question of debate. Principal questions are about which degree of injury should be included, whether the embolization technique should be selective or on the splenic artery trunk, and which materials should be used as embolic agents.^{10,11,12}

Most results of BSI nonoperative management are from United States Trauma Centers¹³, and due to Brazilian Trauma Centers' peculiarities, these results cannot be extended to our daily practice.

In our country there are few articles on this subject. Our research mainly found case series about BSI nonoperative management without the use of embolization.^{14,15} Additionally, national studies evaluating the use of embolization for blunt splenic injuries were not found.

At João XXIII Hospital, during the second semester of 2013, angiography was introduced for blunt injuries to

massive organs and embolization as an adjuvant therapy for blunt splenic injuries, and since 2014, it has been the most frequently-used treatment. This new weapon in the therapeutic arsenal caused a change in the treatment protocol and a wide discussion among the general surgery staff. However, a study evaluating the impact of these changes has not yet been made.

The aim of this study is to compare the success rates of the nonoperative management of grade III and IV BSI without subcapsular hematoma before and after the introduction of angiography with embolization as a therapeutic method.

METHODS

The study was approved by the research ethics committee of the "Fundação Hospitalar do Estado de Minas Gerais" in the technical report 070/2019. All patients, including pediatric patients, with grade III and IV blunt splenic injuries, according to AAST's classification (American Association for the Surgery of Trauma), were included in the study. Figure 1

The study was based on a review of electronic medical reports of patients who underwent nonoperative management of blunt splenic trauma at Hospital João XXIII. The data collection included patients treated between January 2014 and July 2017. The results were compared with a case series at the same hospital, published in 2014, which included patients admitted for the nonoperative management of blunt splenic trauma during the period of November 2004 to December 2013.¹⁶

It should be noted that this study was made possible due to the protocol for the nonoperative management of blunt abdominal trauma to massive abdominal organ that has been used by the General Surgery and Trauma Service of Hospital João XXIII since 2002, having been reviewed and updated in December 2013.¹⁷

Figure 1. AAST Splenic injury

AAST Grade	Injury	Injury Description	AIS-98* Grade
I	hematoma	subcapsular, <10% surface	2
	laceration	capsular tear, <1 cm	2
II	hematoma	subcapsular, 10–50% surface; intraparenchymal hematoma, <10cm in diameter	2
	laceration	1–3cm deep, <10cm long	2
III	hematoma	subcapsular, >50% surface; intraparenchymal hematoma, >10cm	3
	laceration	>3cm parenchymal	3
IV	laceration	parenchymal disruption involving 25–75% of spleen	4
V	laceration	parenchymal disruption involving >75% of spleen	5
	vascular	splenic venous injuries	5
VI	vascular	splenic avulsion	6

*Note–AIS-98 = Abbreviated Injury Scale, 1998 version.

Scaling system for organ specific injuries Ernest E. Moore, MD, Thomas H. Cogbill, MD, Mark Malangoni, MD, Gregory J. Jurkovich, MD, and Howard R. Champion, MD

During Period 1 (2004-2013), angiography and embolization were not routinely used in the nonoperative management of BSI.

In order to be included in the protocol of nonoperative management, patients must be hemodynamically stable on admission (systolic blood pressure greater than 100 mmHg and heart rate less than 100 beats per minute) or stabilized after initial volume replacement, present no signs of diffuse peritoneal irritation, presenting isolated abdominal trauma and Glasgow coma scale at admission greater than or equal to 14. In addition, undergo a mandatory abdominal CT scan. Grade III lesions with subcapsular hematoma were surgically treated, regardless of hemodynamic stability, as this is a poor prognostic factor for nonoperative management. Grade V injuries were not treated conservatively, and all patients sustained this injury underwent surgery regardless of hemodynamic condition.

During Period 2 (2014-2017), angiography with embolization was used as an adjuvant method for the nonoperative management of grade III BSI with signs of contrast extravasation on CT and grade IV BSI (regardless of the presence or absence of contrast extravasation on CT). The clinical criteria for inclusion in the protocol were not changed.

These patients were referred to the operating room by vascular surgery staff, under general anesthesia. Vascular access was obtained by a common femoral

artery puncture and the introduction of a 5-French (Fr) sheath. The celiac trunk was catheterized with a Cobra 4-Fr or a Simmons 5-Fr catheter and the diagnosis of the splenic injury was achieved with an injection of water-soluble contrast and digital subtraction using a Philips BV Pulsera with a C-arm, during apnea. If a splenic vascular injury (pseudoaneurysm, arteriovenous fistula or contrast extravasation) was identified, the organ underwent embolization. When diffuse injuries or various pseudoaneurysms were found, proximal embolization was performed using coils in the splenic artery splenic artery distal to the dorsal pancreatic artery emergency, aiming the preservation of the splenic hilum. If the finding was a focal injury, the spleen underwent selective embolization using a 2.8-Fr microcatheter and polyvinyl alcohol (PVA) particles (300-500 microns) or coils. Routine follow-up CT scans were then carried out.

The study outcome was nonoperative management failure. This was defined as a splenectomy being needed after the initial nonoperative management due to hemodynamic instability or a persistent drop in haemoglobin values. Patients who died and whose deaths were unrelated to splenic injuries, such as severe cranial trauma, were excluded from the analysis.

The analyses were made using the softwares R3.6.3 and MINITAB version 14. The significance level considered was 5%.

Figure 2. Algorithm for blunt splenic trauma nonoperative management 2004-2013

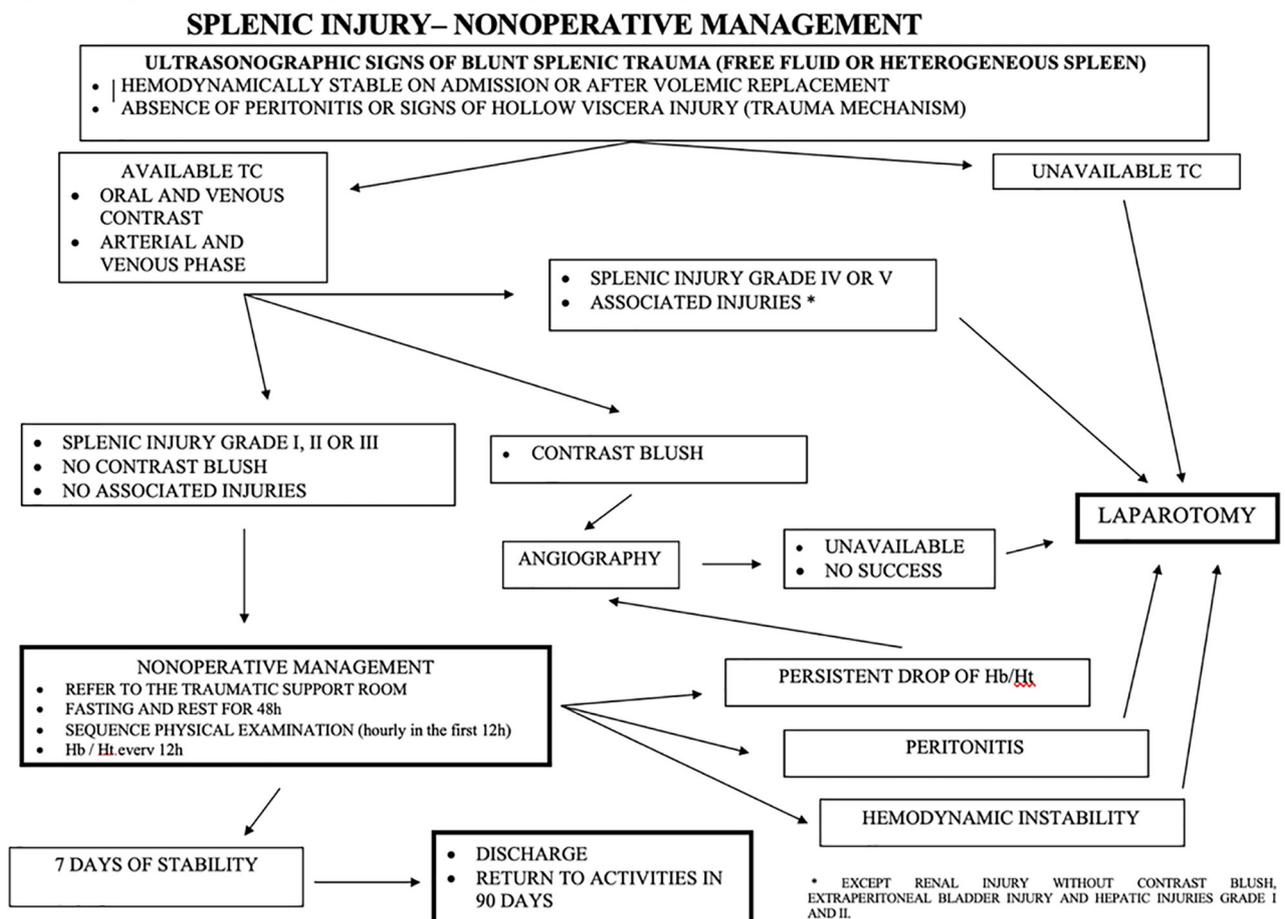


Figure 3. Splenic trauma angiography.



Figure 4. Angiography after splenic trauma embolization.

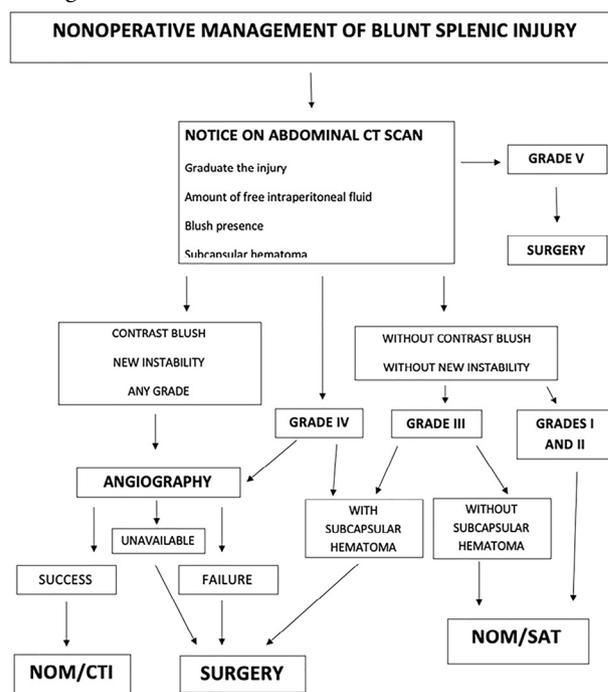


RESULTS

In Period 1, 389 patients were included, 82.8% of which (332) had grade III splenic injuries and 17.2% (67) grade IV injuries. In period 2, 195 patients were included, 56.4% of which (110) had grade III injuries and 43.6% (85) grade IV injuries (Table 1). The inclusion criteria for BSI nonoperative management protocol were identical in both periods.

In Period 1, there were 11% (36 patients) that presented failure in nonoperative management of grade III splenic injury and 33% (22 patients) failure in nonoperative management of grade IV injury. In Period 2, there were 3.6% (4 patients) that presented failure in nonoperative management of grade III injury and 7.0% (6 patients) failure in nonoperative management of grade IV injury. Among

Figure 5. Algorithm for blunt splenic trauma nonoperative management 2014-2017.



the patients treated with NOM, 32 had embolization as an adjuvant treatment (28 coils at the trunk of the splenic artery and 4 selective embolization with PVA particles). (see Table 2 and Graph 1).

In Period 1 there was only one death related to nonoperative management. In Period 2, there was also, only one death related to nonoperative management; a 77-year-old patient with a grade IV injury, which presented severe splenic hemorrhage and multiple organ failure in the postoperative period.

DISCUSSION

Hospital João XXIII has a long history of spleen preservation in trauma cases, beginning with partial splenectomy and/or splenorhaphy in the 1970s, such technique was elaborated by a Brazilian surgeon: Marcelo Campos Christo¹⁸, followed by nonoperative management in the 1990s and finally introducing angiography with embolization in the first two decades of the 21st century.

The aim of this study is to compare splenic preservation rates in two different periods. We observed that the failure rate in BSI nonoperative management was reduced after the introduction of splenic embolization. We analyzed grade III and IV splenic injuries, because they are the ones with the highest failure rate in nonoperative management. Also, minimally-invasive treatment could have a greater benefit for these patients.¹⁹

We do not consider the nonoperative management of grade III and IV BSI with subcapsular hematoma as safe, nor grade V injuries. For this reason, none of these patients were included in the comparison because they underwent splenectomy regardless of the hemodynamic status.

Although some publications have not shown an improvement in the success of nonoperative management of splenic injuries with embolization,^{8,20} this study is in agreement

Table 1. Patients with grade III and IV blunt splenic injuries in Periods 1 and 2.

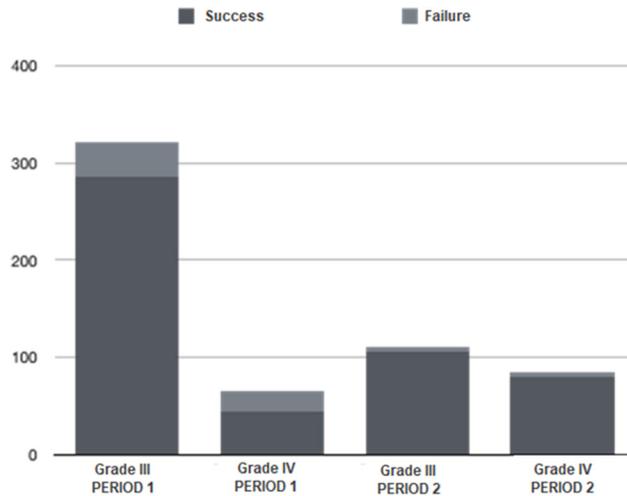
Degree of Injury	Period	
	1 (n = 389)	2 (n = 195)
Grade III	322 (82.8%)	110 (56.4%)
Grade IV	67 (17.2%)	85 (43.6%)

Table 2. Falha no tratamento não operatório da lesão esplênica contusa nos períodos 1 e 2

Degree of Injury	Period		P-value
	1	2	
Grade III	36 (11%)	4 (3.6%)	0.018¹
Grade IV	22 (33%)	6 (7.0%)	>0.0001¹

1. Teste Qui-Quadrado de Pearson

Graph 1. Number of patients with failed and successful nonoperative management of blunt splenic trauma in Periods 1 and 2.



with those studies that have demonstrated a benefit. Ekeh *et al* in an 8-year review showed a reduction in splenic surgeries, but without a reduction in the failure rate of nonoperative management. This can be explained by a type 2 statistical error, due to the small number of patients in the sample.²¹

In a recently-published meta-analysis, which included 23 studies, the benefit of this treatment was proven for grade IV injuries, although it did not demonstrate the same for grade III injuries.¹⁹

One aspect that should be emphasized is that this study, as well as others, made comparisons between different treatment periods, evaluating the success of the treatment before and after the use of embolization to improve the nonoperative management of BSI. Gaarder *et al* demonstrated an increase in the rate of splenic salvage from 57% to 75% after the use of embolization.²² Rajani *et al* also showed a significant increase in success rates in splenic trauma from 77% to 96% when embolization was used as an adjuvant to nonoperative management.²³ Miller *et al* in a prospective study, using a historical series from the same hospital as a control, also showed an improvement in the success of conservative treatment of grade III, IV and V

splenic injuries after the introduction of embolization as an adjuvant treatment.²⁴

Although splenic embolization is not free of risks (for example, contrast-induced nephropathy, bleeding at the puncture site and splenic infarction), it is worth emphasizing that, despite observing some degree of splenic infarction, we did not observe the development of abscesses in our patients.

It was not possible to compare other factors that could influence the analyzed outcome, such as ISS (Injury Severity Score), the Glasgow coma scale on admission, comorbidities, blood transfusion, length of hospital stay, among others. This was due to the significant loss of data in Period 1, which preceded the implementation of electronic medical reports at the hospital. Despite this, we can infer that these patients' characteristics were similar between both periods. We can infer this because of the following factors: the profiles of patients admitted to our hospital did not change during the analyzed times, also they continue to be, mostly, young patients without comorbidities; the qualification for nonoperative management of BSI did not change between periods - patients had to be hemodynamically stable, without peritoneal irritation and were all submitted to abdominal CT scans. Patients who died due to severe cranial trauma were removed from the analysis of both groups. Finally, the team of surgeons who coordinated the nonoperative management of these patients did not change during the periods.

Our study has several limitations, in addition to those inherent in any retrospective study. We may have some bias due to improvements in intensive care, improvements in tomographic technology because of the introduction of more modern machines in Period 2, a gain in experience of the teams involved in the nonoperative management of these patients over time and, in addition, the fact that our study did not analyze isolated splenic traumas, but polytraumatized patients.

In conclusion, the nonoperative management of BSI with splenic angioembolization as an adjuvant is safe and is associated with a reduction, with statistical significance, in the need for a splenectomy for grade III and IV blunt splenic injuries, without subcapsular hematoma.

However, it is necessary to continue using this protocol for a longer period of time in order to be able to validate the results obtained with more accuracy.

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