

# Multimodality Management in Severe Pediatric Spleen Trauma

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## Abstract

**Background:** Trauma is the leading cause of death in children. In abdominal lesions the spleen is the most commonly involved organ. During the last two decades much effort has focused on spleen tissue conservation.

**Objectives:** To analyze the rationale of a multimodality management policy that includes autotransfusion and mesh wrapping.

**Methods:** Data gathered over 14 years illustrate the introduction of new techniques and their impact on cases of severe spleen rupture.

**Results:** A total of 122 children were treated during the 14 year period, 1985–98. In 16 children an absorbable mesh wrapping, alone or in combination with other techniques, was used to obtain hemostasis and save spleen tissue.

**Conclusions:** Mesh wrapping, partial splenectomy and autotransfusion can be used, alone or in combination, to preserve severely injured spleens. According to our records, all children survived with a functional spleen. There were no cases of rebleeding. In only one case of prolonged postoperative fever could the cause be traced to an infected spleen hematoma that was drained transcutaneously. Autotransfusion is performed simply and without the use of a "cell saver." Its use can be crucial in small or field hospitals or in a situation of mass casualty.

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Tissue conservation has become one of the main objectives in the treatment of children with traumatic rupture of the spleen [1–4]. Spleen surgical salvage procedures in pediatric trauma reflect the accumulated knowledge on its role in cellular and humoral immunology [5]. Both non-operative management and conservative surgical measures must be individualized in order to result in approximately 80% spleen salvage [6]. The present report describes a subgroup of children in whom a combination of techniques, including autotransfusion, partial splenectomy and mesh wrapping, proved successful in preserving seriously damaged spleens that would otherwise have been removed completely.

## Patients, Methods and Results

During a period of 14 years (1985–1998), 122 children were

treated in our medical center for blunt spleen rupture. They included 78 males and 44 females aged between 2 and 15 years. Sixty children had been involved in motor vehicle accidents, 30 of them as pedestrians. Bicycle handlebars caused spleen injury in 28 cases, sport trauma in 19 and falls in 15 children. The spleen was the only organ injured in 93 children. Nine children had associated thoracic or head injuries. Limb injuries were present in five cases. The liver (8 cases), small bowel or mesentery (4 cases), left kidney (2 cases) and pancreas (1 case) were the main abdominal associated lesions. Eighty children were initially treated non-operatively, but in six cases the policy was changed to surgical measures because of the need for continuous blood replacement or suspected intra-abdominal associated lesions. Two children with head injuries died. Ten children were submitted to total splenectomy, 12 were treated by splenorrhaphy and 16 by mesh wrapping alone or in combination with other techniques. Stable children, in accordance with the ATLS directives, were evaluated by ultrasonography, but since the advent of spiral CT, or in cases of polytrauma, spiral CT has become the imaging method of choice. In the wrapping subgroup, spleen rupture was diagnosed by CT in eight children, US + CT in three cases and during exploratory laparotomy in five children. The degree of spleen damage was recorded according to a modified classification of five types [Table 1]. Wrapping was total in all cases and all children recovered and preserved a functional spleen. Great care was exercised during spleen luxation for initial damage evaluation. Gentle manipulation is

**Table 1.** Classification of spleen injuries

|           |   |
|-----------|---|
| Type I:   | Capsular avulsion without significant parenchymal damage. No active bleeding.   |
| Type II:  | Capsular disruption with parenchymal damage that can reach the hilum without involving it. When the capsula is intact a subcapsular hematoma develops.    |
| Type III: | Deep transversal laceration(s) dividing the spleen into vascularized areas. When the capsula is intact a rapidly enlarging subcapsular hematoma develops. |
| Type IV:  | Multiple parenchymal fragmentation with partial hilar vessel damage.  |
| Type V:   | Spleen avulsion   |



**Figure 1.** Wrapped spleen in place after autotransfusion and lower pole splenectomy

mandatory so as not to add parenchymal rupture that would upgrade the lesions and possibly lead to splenectomy. Detached fragments and clots were removed and temporary hemostasis was obtained by packing. Free intraabdominal blood was collected with a syringe and mixed with normal saline solution for simple intravenous reinfusion through a 40  $\mu$  filter into a peripheral or central vein. Eight children with Type IV isolated spleen lesions had their spleens conserved by initial autotransfusion followed by partial splenectomy and mesh wrapping. An absorbable mesh (polyglycolic or polyglactin 910) was used because of its easy molding capacity, bacteriostatic properties and self-bolstering action that do not interfere with spleen growth after a neocapsule is formed [Figure 1]. The amount of blood autotransfused varied between 250 and 400 ml before dilution. No anticoagulants were added.

Drains were inserted in all cases but were removed early. Although their use is not free of controversy, it is now our belief that they are not necessary. Four children with a wrapped spleen (25%) had a prolonged (2 to 3 weeks) period of fever of unknown origin that proved to be autolimited. In one case a perisplenic abscess was drained transcutaneously.

A gradual return to normal activity was allowed after 4 weeks. The children and their parents were advised that competitive sport should be avoided for at least 6 months, but we have to admit that there are insufficient guidelines or data about the period of restrictive activity.

## Discussion

The clinical observation that spleen bleeding could often be controlled temporarily by packing and by manual pressure suggested that a spleen could be saved if a permanent tamponade was obtained. Perisplenic wrapping started in the seventies when omental wrapping cocooned with encircling sutures succeeded in stopping bleeding and keeping fragments together [7]. The desired tamponade effect is the result of local compression. Mesh wrapping was introduced

by Buntain and Lynn [7]. Experimental and clinical reports followed, and confirmed that mesh wrapping was feasible and effective to save spleens that otherwise would be removed [8,9]. The mesh creates a neocapsule that is absorbed by the end of 12 weeks and does not interfere with spleen growth. Blunt spleen rupture in children has specific characteristics. Most injuries occur in transversal planes. This helps to maintain vascularized segments [10] and favors partial resection. The pediatric spleen is easier and safer to suture than in adults because of its high capsular-parenchymal ratio [11]. Segmental spleen resection was first suggested by Jules Pean in 1869, long before its hematological and immunological importance was recognized [12,13]. The first successful series of segmental splenectomy was reported in Brazil by Christo [14] and his experience, confirmed by others, is today widely accepted [15].

The raw surface of the spleen is dealt with in numerous ways, such as suture, stapling or mesh wrapping. Absorbable mesh wrapping is a logical choice because the spleen is already mobilized. When an absorbable mesh is not available, omental wrapping or an improvised catgut net are good alternatives [16]. The complementary use of mesh wrapping has also been performed to obtain hemostasis of the raw surface of traumatized livers. Massive active bleeding in children with isolated spleen rupture is due to severe lacerations usually with some hilar damage [17,18]. These children often do not benefit from non-operative management and many of them are sent to the operating room directly from the emergency room [19]. After the abdomen is opened, a four-quadrant packing is followed by intraperitoneal blood collection. The amount is measured, and if there is more than 200 ml it is mixed with normal saline and reinfused through a proper filter, even in the presence of a hollow viscous perforation [20].

The equipment needed to perform the autotransfusion is found in almost every operating room. It has also been performed during laparoscopic procedures in trauma patients [21]. We do not use a "cell-saver" and the autotransfusion is done simply, in a cost-effective way, with minimal red cell membrane damage. The risk of blood transmitted diseases is eliminated altogether. This technique can be crucial in field or small hospitals [22] or in mass-casualty situations when there is a shortage of blood on hand [23]. In this era of conservative management of spleen trauma, surgeons familiar with wrapping techniques will find, especially in severe cases [24], that blood reinfusion, partial splenectomy and spleen wrapping represent rewarding options [25].

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