A Simple and Novel Rivet-Type Repair Technique for Traumatic Rupture of Spleen

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Abstract: Traumatic spleen rupture is a common abdominal emergency that requires immediate diagnosis and prompt surgical treatment to ensure the patient's survival. The operative indications of spleen-preserving therapy and the choice of surgical methods directly affect prognosis. Preservation of splenic function is the principle clinical aim, and many spleen-preserving surgical methods have been developed including simple suture repair, suture repair, pedicled omentum tamping, partial spleen resection, splenic artery embolization by intervention, and spleen transplantation. The most effective surgical option for maximum preservation of function and best prognosis depends on the extent and the classification of the rupture. Substantial rupture often increases the surgical depth of field and leads to the difficulties of exposing the splenic hilum. Under these circumstances, common repair methods are prone to failure. The authors developed a new “rivet-type” repair technique using omental tissues. From June 2005 to September 2012, they used this technique to treat 18 cases of deep spleen rupture. This repair method is relatively simple, easily applied to different rupture sizes and locations, and creates a hemostatic effect, which is especially suitable for the splenic hilum fracture. The aim of this article is to describe the surgical protocol and evaluate the rivet-type repair method for spleen preservation after traumatic spleen rupture. Potential problems that may be encountered during this procedure are also highlighted.

Key words: traumatic spleen rupture, splenic hilum fracture, spleen-preserving therapy, rivet-type repair technique

The spleen is a highly vascular and fragile organ easily ruptured by traumatic abdominal impact, which can lead to life-threatening hemorrhage. Rupture of the spleen accounted for 20%-40% of all closed abdominal injury and 10% of open abdominal injury for nearly a decade. The incidence of abdominal trauma and spleen rupture has increased dramatically in developing countries like China due to the rapid development of transportation infrastructure and increasing car traffic. Splenectomy was once a standard treatment for spleen rupture, but modern treatments emphasize maximal preservation of splenic function. The
spleen-preserving operation method chosen depends on the lesion type, location, and depth. Spleen ruptures can be classified as central type (deep rupture into the red and white pulp), subcapsular rupture (subcapsular hematoma), and true rupture (damage involving the capsule). In China, spleen ruptures are classified from level I to IV according to lesion depth, length, and whether the lymphatic efferents, splenic artery, and/or splenic vein are involved (the sixth China spleen surgical academic seminars, Tianjin, 2000). Common spleen-preserving surgical methods include simple suture repair with or without pedicled omentum tamponade, partial splenectomy, splenic artery embolization, and transplantation.

Simple suture repair, a practical operation, is suitable for most patients with a spleen rupture. However, for substantial level II and III damage involving the splenic vessels or deep lesions with concomitant exposure difficulties, these methods are often insufficient. For such serious cases, the authors developed a rivet-type repair technique. Eighteen cases of substantial spleen injury where this technique resulted in satisfactory outcome are reported here. This operation was reliable, minimized bleeding, greatly reduced the operation time, and proved beneficial for recovery. This article retrospectively reviews the authors’ clinical experience and analyzes the efficacy and safety of this spleen repair procedure.

**Materials and Methods**

Of 55 splenic rupture cases treated between June 2005 and September 2012, 18 were treated using a new rivet-type repair technique. The characteristics of the patients were 13 males and 5 females, mean age of 36 years and a range of 17-55 years. The causes of injury included traffic accidents (6 cases), falls (6 cases), crushing (3 cases), and assaults (3 cases).

The delay between injury to admission ranged from 0.5-42 hours, with an average of 2.8 hours. Twelve cases showed stable hemodynamics on admission, while 6 patients were in shock (shock index > 1.0). Associated injuries included rib fractures (5 cases), pneumothorax (2 cases), liver rupture (2 cases), diaphragm rupture (1 case), pancreatic injury (2 cases), renal contusion (3 cases), visceral cavity injury (4 cases), cranio-cerebral injury (2 cases), and limb and pelvic injury (2 cases).

All 18 patients’ diagnoses were based on trauma history, symptoms, signs, diagnostic abdominal puncture (positive rate, 92.2%), B-mode ultrasound imaging of the abdomen (positive rate, 93.1%) and/or CT scan (positive rate, 93.5%), and other auxiliary examinations. The diagnosis rate for combined B ultrasound and CT was 96.3%. According to the Spleen Damage Degree Classification standards established by the Chinese Medicine Surgery Branch (Spleen Surgery) at the The 6th National Symposium on Spleen Surgery of China held in September 2000 in Tianjin, and based on B-mode ultrasound and/or CT scan, 10 cases were classified as level II and 8 cases were level III.

**Surgical method.** The authors first looped double strands of 2-0 silk thread (15 cm long) through the end of a straight needle and fed the needle through a small section of isolated omentum majus tissue (Figure 1). The spleen was first surgically separated so it could be moved to the abdominal incision space. A no-damage vascular clamp was used at the splenic pedicle to control splenic artery and vein bleeding, clear any blood clotting, and the spleen inactivated tissue in the cleft. The straight needle should be taken from the lower pole of the spleen through the ruptured wounds to the upper pole of the spleen. The rupture is then sutured from the inferior to superior pole (Figure 2). The needle is then removed and the suture cut, placing a small piece of omentum majus tissue at the thread end, which is then knotted to form a tissue “rivet” (Figure 3). This suturing procedure is repeated 3 times at about 1.0-1.5 cm intervals to achieve hemostasis. Suturing is
followed by application of gelatin sponge tamponade, local adhesive, and omentum majus tamping. A drain-age tube is then inserted below the diaphragm. This surgical technique was performed by the same experienced surgeon in all 18 patients.

Results
All 18 patients treated using the rivet technique survived surgery and were monitored for 1–60 months postoperation. Two cases were complicated by a small amount of postoperative bleeding which was controlled by conservative treatment. During follow-up, no overwhelming postsplectomy infection, subphrenic abscesses, splenic abscesses, or intestinal obstructions occurred. Eleven patients experienced postoperative fever, which was cured within 1 week by indomethacin suppositories.

Discussion
The spleen is a critical organ for blood filtration and immunological function. It recycles iron from hemoglobin, stores B- and T-cells, filters bloodborne antigens, and can inhibit the spread of cancer cells. Damage to the spleen thus disrupts immune regulation and response to infection, antitumor mechanisms, and endocrine functions. Indeed, spleen resection results in increased susceptibility to certain types of infections. For example, postsplectomy pneumococcus infection poses a potential danger to infants and young children. The success of this surgical spleen repair technique in all 18 patients, and the absence of severe postoperative complications (particularly infections), indicate the spleen can repair itself and resume normal functioning following fusion of the laceration. It provides the pathologic basis for the spleen-preserving operations. So, in adherence to the “rescue the life first, keep spleen second” principle, retention of the spleen, particularly in children, has been accepted by most surgeons. Each sort of spleen-preserving surgery employed depends on specific indications and conditions. No operation can apply to all patients; it should be based on the individualized assessment and comprehensive treatment of each case.

The ideal reparative surgery should be relatively simple, applicable to a wide range of spleen injuries, result in minimal blood loss, and, most importantly, preserve splenic function over the long term. For ruptures classified as level I-III, this rivet technique proved safe and
effective. Intermittent or pad type sutures can disrupt spleen organization, and cause unacceptable bleeding. Because deeper lacerations are difficult to suture due to challenges related to exposure, the general repair method will be prone to failure. In contrast, this direct rivet-type repair method reduces blood loss, even in cases of damage to the splenic circulation. In all 18 cases, the patients recovered without complication and follow-up B-mode ultrasound revealed no abnormalities such as subphrenic or splenic abscesses.

**Conclusion**

This rivet-type repair method can effectively treat level I-III ruptures of the spleen, even in cases with deep or large lacerations. The technique is simple, results in minimal bleeding, and, most importantly, obviates the need for splenectomy.

**References**