

ORIGINAL ARTICLE

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CT appearance of the spleen following conservative management of traumatic injury

Abstract *Objective:* To describe the long-term changes in the traumatized spleen following conservative management in pediatric patients. *Methods:* Between 1991 and 1997, 92 children were imaged with splenic trauma. The study population includes the 25 boys and 11 girls with follow-up computed tomography (CT) imaging at our institution. The follow-up CT studies were evaluated to determine the evolution of splenic injury. *Results:* On initial CT there were 6 grade I, 12 grade II, 9 grade III, and 9 grade IV–V splenic injuries. In follow-up 11 spleens were normal (30%), including at least one in each grade of severity of injury. Splenic abnormalities were identified on follow-up in 25 children. These findings comprised clefts in 8 children, small cysts in 4, and devascularized segments involving less than 1 cm³ in 6, 1–2 cm³ in 2, and 2–4 cm³ in 5 children. *Conclusions:* All grades of splenic injury can resolve completely on subsequent CT imaging. In this series 30% of patients had a normal follow-up CT. The most common persistent abnormalities included clefts and devascularized areas less than 4 cm³.

Key words Splenic trauma · Splenic scar · Computed tomography · Pediatric trauma

Introduction

Nonoperative management of hemodynamically stable splenic injuries in children is the standard of care at most pediatric institutions [1, 2]. Although publications have examined follow-up computed tomography (CT) studies after the acute splenic injury and reclassified the degree

of injury using the acute traumatic classification, information on the descriptive appearance of the late, persistent post-traumatic splenic abnormalities is limited [3, 4]. Our interest was prompted when a young child was imaged following the second serious motor vehicle accident in his short life. We wondered whether the long-term appearance of the previously injured spleen could be differentiated from acute injury to the spleen. The purpose of this study was to describe the late, persistent characteristic findings on CT imaging in these children.

Materials and methods

Between 1991 and 1997, 92 children (mean age 10.2 years) were diagnosed with splenic trauma on CT imaging. Eleven of the children required splenectomy for hemodynamic instability from injury to the splenic vasculature (12%). There were 3 deaths among the 92 children from severe intracranial injuries, these 3 children had no further abdominal imaging. Of the remaining 78 children, 42 had no CT follow-up at our institution. Several of these patients were managed clinically without further imaging, some were imaged on follow-up with sonography, and others were transferred to other institutions for subsequent care. The study population comprises the 36 children (25 boys and 11 girls) with subsequent CT imaging at this institution. The initial CT images were graded for severity of splenic injury using a scale of I through V modified from surgical grading scales [5, 6]. Grade I is less than 10% injury to the spleen, grade II is 10–20% injury, grade III is 20–50% splenic injury. Grade IV, more than 50% injury, was combined with grade V, “shattered”, since the distinction between the two seemed somewhat arbitrary. All subsequent CT studies were evaluated for time interval from the injury and evolution of the splenic abnormalities. In this study population of 36 patients the age range was from 6 months to 17 years. The mean age of the 36 patients was 10.8 years with a median of 11 years, similar to the total population of 92 children.

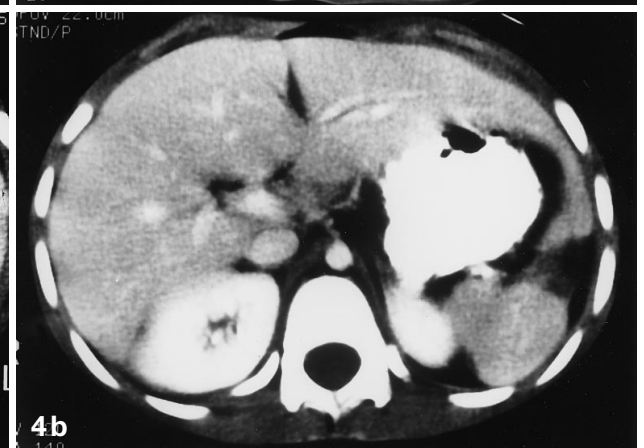
Results

At presentation there were 6 grade I, 12 grade II, 9 grade III, and 9 grade IV–V splenic injuries. The follow-up CT imaging studies were not done at any specific designated time. Many of the imaging studies were ordered to evaluate other problems in the patient. Due to the

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combination of other injuries necessitating interval CT studies and management by a number of clinicians, the actual timing and number of studies varied considerably. Eleven normal spleens were seen on CT on follow-up (Fig. 1). The spleen was found to have a normal appearance on CT scans ranging from 2 to 13 weeks following the acute injury (mean 7.9 weeks). The distribution of the initial splenic injury severity grade with a subsequent normal CT appearance of the spleen on follow-up was as follows: 2 of the 6 patients with a grade I injury (33%), 7 of the 12 with a grade II (58%), 1 of the 9 with a grade III (11%), and 1 of the 9 with a grade IV–V (11%) (Fig. 1). Those children with less than 20% volume injury to the spleen (grades I and II) included 9 of the 11 with a normal appearance on follow-up imaging. Thus 50% (9 of the 18) of the children with an injury involving up to 20% of the spleen ultimately returned to a normal appearance. Conversely, only 2 of the 18 children with a greater than 20% splenic injury (11%) returned to normal. Persistent late abnormalities were identified in 25 of the spleens. Nine of these children had two or more follow-up CT studies revealing stability of these scars. The scars included clefts in 8 (Fig. 2), small cysts in 4 (Fig. 3), and devascularized segments involving less than 1 cm³ in 6, 1–2 cm³ in 2, and 2–4 cm³ in 5 children (Fig. 4). The earliest a stable scar was identified was 6 weeks following injury.

Discussion

One previous report on resolution of splenic injury indicated that 11 of 25 injured spleens had a normal appearance on the follow-up CT 6 weeks after injury (44%) [3]. In the study by Benya and colleagues, the grade of injury was correlated with the length of time to healing, but the proportions of eventually normal spleens and the healed abnormalities were not defined [4]. In our series 30% of the patients had a final totally normal CT appearance of the spleen. The distribution of normal subsequent appearance of the spleen disproportionately involved the lesser grades of injury. It is notable that 50% of the children with an injury involving less than 20% of the volume of the spleen had a final normal spleen on CT imaging. However, several of the most severely injured spleens evolved to a normal final appearance, though the percent age was much smaller (11%).

◀ **Fig. 1 a** A 17-year-old boy with a grade IV–V injury to the spleen.
b Follow-up CT 6 weeks after injury

Fig. 2 a A 13-year-old boy with a grade I injury to the spleen.
b Follow-up CT 3 months after the injury reveals a small cleft (*arrow*)

Fig. 3 a A 12-year-old boy with a grade IV–V injury to the spleen.
b Follow-up CT at 7 weeks reveals a cyst (*C*), the largest in this series. The subsequent CT study at 10 weeks was unchanged

Fig. 4 a A 5-year-old girl with a grade IV–V injury to the spleen.
b A residual devascularized scar in the spleen, the largest residual splenic abnormality, is seen in this child at 8 weeks after injury

We have provided a representative description of the late abnormalities or chronic scars found in the traumatized spleen in the child on CT (Figs. 2–4). Although we each have an anecdotal case of a large post-traumatic splenic cyst necessitating intervention, the number and size of splenic cysts were both relatively small in this population. Splenic cysts were not a problem in any of the cases. The devascularized areas were also relatively small. No surgical resection of these areas was required in any of the children in this population. No child in this series developed an abscess or late complication of the splenic injury.

Conclusion

All grades of splenic injury can return to a normal appearance on subsequent CT imaging. Thirty percent of all conservatively managed splenic injuries will have a normal late appearance. When the total volume of acute splenic injury is less than 20% of the spleen there is a 50% chance of return to normal appearance. The most commonly identified late abnormalities are clefts, small cysts, and devascularized areas less than 4 cm³ in size.

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Editorial comment

Over the last two decades the treatment of splenic injuries in children has undergone a virtual turnaround. Conservatism is the rule and outcome usually is very good. Because of the conservative treatment of splenic injuries, follow-up CT studies are now commonly obtained. This communication will serve a very useful function in that it delineates in detail the various appearances of the spleen after injury, and shows that by and large these findings can be ignored.

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