

# Blunt Injury of the Abdominal Aorta

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This review of 27 cases of blunt injury of the abdominal aorta includes 24 cases reported in the literature and three new cases. Automobile accidents were the cause of this condition in 19 patients (70%). Clinical presentation was acute in 70% of the cases, and consisted of either acute arterial insufficiency or an acute abdomen. Intimal disruption occurred in 15 patients (55%) and was the most common anatomic lesion. Atherosclerotic involvement of the aorta was found in ten patients (37%), and in four it contributed directly to the development of this condition. The infrarenal aorta was the most affected segment (92%). The mortality rate was 29% (8/27 patients). Associated trauma occurred in 55% of the cases, but did not increase the mortality rate. Prompt recognition and proper surgical treatment are essential in the management of this condition.

BLUNT INJURY OF THE abdominal aorta is a rare entity, as indicated by the scarcity of reports in the literature. Aortic lesions resulting from direct mechanical forces include simple contusion, intimal disruption, intramural hematoma, false aneurysm and frank rupture. The addition of three new cases has provided the opportunity to discuss the physiopathology and the mechanisms of injury, the clinical syndromes resulting from the different types of injury, as well as the treatment of this condition.

## Materials and Results

All cases of blunt injury of the abdominal aorta reported in the English literature<sup>1-21</sup> have been reviewed with the addition of the authors' experience with three new cases. This paper summarizes the relevant findings and conclusions. Males outnumbered females by 19 to eight. Automobile accidents rank first as the cause of this condition: ten patients sustained steering wheel injuries, five were struck by an unknown structure in their vehicle and four had a seat belt injury. Eight patients are included in a group of blunt injury of the abdominal aorta from miscellaneous causes (Table 1).

The clinical presentation was acute in 19 cases: signs of acute arterial insufficiency (15 patients) or acute abdomen (three patients) appeared shortly after the

injury. Eight patients had late clinical symptoms. In these eight patients, the time interval between the injury and onset of symptoms ranged from two weeks to one year, with a median of five months. The symptoms and signs encountered were simple claudication (two patients), an abdominal bruit with an abdominal mass (two patients), persisting abdominal pain (two patients), abdominal bruit with decreased pulses (one patient), and finally an abdominal bruit alone (one patient) (Table 2). Aortography was performed in each of 13 patients (48%) and proved to be accurate in all cases. A typical aortogram illustrating intimal disruption with secondary thrombosis is shown in Figure 1.

The pathology of blunt injury of the abdominal aorta is presented in Table 3. Intimal disruption occurred in 15 patients, and was the most common type of injury. Secondary aortic thrombosis ensued in ten of these patients. Three patients had a false aneurysm, and one presented with a true aneurysm. One patient had an intramural hematoma with secondary aortic occlusion and two patients had a late fibrous stenosis of the aorta. An acute thrombosis in a pre-existing aortic aneurysm occurred in one patient. A case of severe aortic athero-

TABLE 1. *Blunt Injury of the Abdominal Aorta*

Type of Accident	
Steering wheel injury	10
Abdominal trauma from miscellaneous causes	8
Gun butt	
Surfboard	
Drying machine	
Fall from a swing	
Struck by a car	
Struck by a train	
Fall from stairs	
Cattle wire	
Car accidents (mechanism undetermined)	5
Seat belt injury	4

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TABLE 2. *Clinical Manifestation*

Acute Manifestation (19 cases)		Chronic Manifestation (8 cases)	
Acute arterial insufficiency	15	Persistent abdominal pain	2
Acute abdomen	3	Claudication	2
Bruit and weak pulses	1	Abdominal bruit and mass	2
		Bruit and decreased pulses	1
		Bruit	1

sclerosis with distal embolization of atherosclerotic debris secondary to a blunt trauma is also described. Finally, three cases are labeled posttraumatic thrombosis due to the absence of other details.

Figure 2 illustrates the anatomic distribution of aortic injuries reported in this review. The infrarenal aorta is the segment most commonly involved (25/27); the distal portion of the infrarenal aorta, i.e. distal to the inferior mesenteric artery, was affected in 12 of the 27 patients. The suprarenal segment of the abdominal aorta was affected only in two patients.

Twenty-five patients underwent surgery for their aortic injury (Table 4). Seventeen patients had a bypass graft inserted (tubular or bifurcation), four each had a thromboendarterectomy, flap suture was performed in three patients and one patient had a lower limb embolectomy.

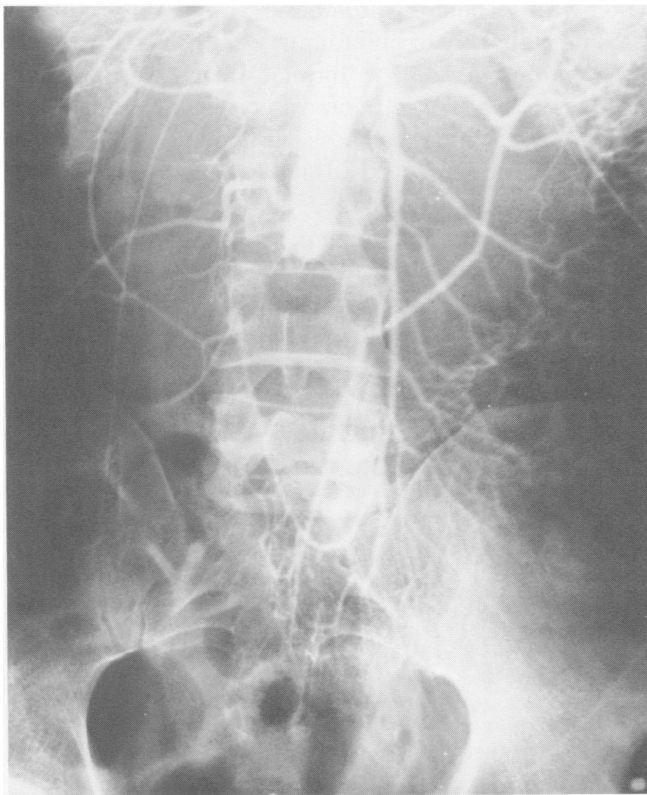


FIG. 1. Aortogram showing complete thrombosis of the distal abdominal aorta secondary to blunt abdominal injury.

Eight patients died of their aortic injury. Associated injuries did not contribute to a higher mortality rate. Fifteen patients with 17 associated injuries, most of them related to the bowel, had a mortality rate of 4/15, while the mortality rate of patients without associated injuries was 4/12. Massive peripheral embolization contributed to the death of two patients. Early postoperative myocardial infarcts were also responsible for the death of two patients. The cause of death was undetermined in two patients, and two patients were not treated for their vascular injuries, which eventually proved to be fatal.

### Discussion

Blunt injury of the abdominal aorta is a rare condition. The combined studies of Parmley and Strassman on 8,710 autopsies done on trauma fatalities revealed 347 cases of nonpenetrating aortic trauma, of which only 16 cases involved the abdominal aorta (4.6%).<sup>22,23</sup> More recently, many series of arterial injuries have been reported, but little mention is made of blunt injury of the abdominal aorta.<sup>24-29</sup> In contrast to the thoracic aorta, where sudden deceleration is the main cause of injury, blunt injury of the abdominal aorta usually involves a direct force which crushes the aorta against the lumbar spine. Steering wheel injury is by far the most common cause<sup>17</sup> and, in such cases, the impact affects a small area of the abdominal aorta where most of the force has been exerted.<sup>18</sup> Indirect force plays a minor role in abdominal aortic injury, and mainly affects both mesenteric arteries and aortic collaterals. The abdominal aorta represents a relatively fixed structure, whereas both mesenteric arteries are more mobile and thus have a different rate of deceleration. Also, in major blunt abdominal trauma, the abdominal content is forced into the pelvis pulling on its vascular attachment (both mesenteric arteries). This peculiar phenomenon combined with unequal deceleration explains the rupture of the superior mesenteric artery and inferior mesenteric artery encountered as associated lesions and this rupture usually occurs near their origin.

The role of atherosclerosis as a predisposing factor in blunt aortic trauma has been debated in the past.<sup>16</sup> Ten patients in this review showed various degrees of

aortic atherosclerosis, and in four of these ten patients (40%), atherosclerosis was found to be significant in the genesis of their aortic lesion. In the other six patients, atherosclerosis appeared as an incidental feature with no apparent consequence. The state of the anterior abdominal wall is of some importance and is often mentioned in this context. This structure is the first barrier against external force and its strength and state of contraction are of definite importance in the mechanism of injury, although the clinical evaluation of this factor is difficult.

The anatomic lesions are listed in Table 3. Disruption of the intima is the most common anatomical lesion encountered clinically, and this disruption can be partial or involve the entire circumference. The inferior intimal flap is frequently dissected by the blood flow and this dissection may extend downward for several centimeters. At this point, complete thrombosis and acute arterial insufficiency usually supervene. Intramural hematoma with occlusion occurred in one patient, but may well have been the initiating factor in the two cases of late fibrous stenosis. The rupture of all layers leads to a false aneurysm or to frank intraperitoneal rupture and, in the latter case, the survival is jeopardized as a result of the rapid exsanguinating nature of the injury.

As stated previously, blunt injury of the abdominal

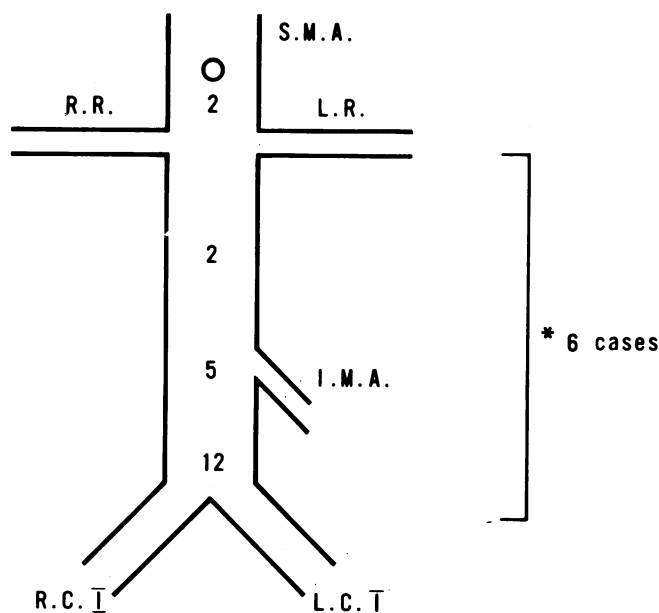


FIG. 2. Blunt injury of the abdominal aorta: anatomic localization and frequency of injuries. R.R.: Right renal artery. L.R.: Left renal artery. S.M.A.: Superior mesenteric artery. I.M.A.: Inferior mesenteric artery. R.C.I.: Right common iliac. L.C.I.: Left common iliac. \*Infrarenal localization, no further specifications.

TABLE 3.

Authors	Pathology
Ricen <sup>1</sup> 1942	False aneurysm
Walker <sup>2</sup> 1961	Aortic thrombosis
Kleinert <sup>3</sup> 1961	Intramural hematoma
Ngu <sup>4</sup> 1965	Intimal dissection and thrombosis
Griffen <sup>5</sup> 1966	False aneurysm
Tomatis <sup>6</sup> 1968	Intimal disruption and thrombosis
Ryback <sup>7</sup> 1969	Fibrous stenosis
Campbell <sup>8</sup> 1969	Intimal dissection. S.M.A.* stenosis
Welborne <sup>9</sup> 1969	Intimal dissection and shearing of I.M.A.†
Borja <sup>10</sup> 1970	Acute thrombosis
David <sup>11</sup> 1970	Intimal dissection. S.M.A.* stenosis
Hewitt <sup>12</sup> 1970	Intimal disruption and thrombosis
Thal <sup>13</sup> 1971	Intimal disruption and thrombosis
Thal <sup>13</sup> 1971	Intimal disruption and thrombosis
Nunn <sup>14</sup> 1973	Intimal disruption
Matolo <sup>15</sup> 1974	Intimal disruption and thrombosis
Matolo <sup>15</sup> 1974	Stenosis of distal aorta
Mozingo <sup>16</sup> 1975	Aortic thrombosis
Sloop <sup>17</sup> 1975	Intimal disruption
Sloop <sup>17</sup> 1975	Intimal disruption
Sethi <sup>18</sup> 1975	False aneurysm
Hertzer <sup>19</sup> 1977	Atherosclerotic debris
Boontje <sup>20</sup> 1978	Traumatic aneurysm
Dajee <sup>21</sup> 1979	Intimal disruption and thrombosis
Lassonde 1981	Acute thrombosis of an abdominal aortic aneurysm
Lassonde 1981	Intimal disruption and thrombosis
Lassonde. 1981	Intimal disruption and thrombosis

\* Superior mesenteric artery.

† Inferior mesenteric artery.

aorta mainly affects the infrarenal aorta (Fig. 2). The midabdominal localization of the distal aorta renders this segment highly vulnerable to direct trauma while the suprarenal segment affords a better protection from the lower thorax. This anatomic localization probably explains the relative proportion of injury reported in these segments.

The clinical presentation of most cases of blunt injury of the abdominal aorta poses no major diagnostic problem, although in some instances, such as intimal disruption without thrombosis, the diagnosis might be elusive. A high suspicion index as well as a good knowledge of this condition are essential to the diagnosis. It should be suspected in all cases of severe blunt trauma to the abdomen.

Aortic angiography is the best technique to confirm the diagnosis of aortic injury. It should be performed, when possible, in all patients with blunt abdominal trauma showing signs of vascular involvement.

The treatment of this condition depends on the state of the injured aorta. Simple intimal disruption without extensive dissection may be corrected with flap suture. An extended dissection requires a thromboendarterectomy. Badly damaged aortas, which include false aneurysm, significant hematoma of the aortic wall and fibrous stenosis, are best managed by graft replacement provided the abdominal cavity is free of any contamination which may occur as a result of an associated

TABLE 4. Operative Procedures in 25 Patients

	Number of Patients
Graft replacement	17
Thromboendarterectomy	4
Intimal suture	3
Embolectomy	1

bowel lesion. If gross contamination exists, any vascular procedure on the aorta should be deferred unless hemorrhage is present. Acute arterial insufficiency in these contaminated cases is corrected by an extra-anatomic bypass. Experience and individualization of the cases aid in the management of these difficult problems. Catheter embolectomy of the distal vascular bed must be done routinely in all cases of acute traumatic thrombosis since peripheral embolization appears to be a common feature of this condition (35%).

The mortality rate of reported cases of blunt injury of the abdominal aorta was 8/27. Prompt recognition of this condition and successful treatment of massive embolization could have changed the fatal prognosis in three patients. In the two patients with cardiogenic shock, it is doubtful that any therapy would have resulted in their survival. The occurrence of associated abdominal lesions in 55% of the patients illustrates the importance of a complete abdominal exploration in blunt injury of the abdominal aorta. Seat belt injury of the aorta deserves special attention since it involves a 100% incidence of associated bowel trauma. It is noteworthy that associated injuries which usually involve the small and large bowel did not increase the mortality rate. The benign nature of most of these injuries would explain this observation. This review of 24 reported cases of blunt injury of the abdominal aorta and the addition of three new cases more clearly define the features of this condition and should aid in its comprehension and management.

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