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Penetrating arrow injuries in Western India

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Thoracotomy;
Laparotomy

Summary

Background: Though penetrating arrow injuries are a rarity in the West, they are still seen frequently among the tribal population of India. This study was performed with the aim of documenting the clinical profile of injuries caused by arrows, the varied modes of clinical presentation and their management at a university hospital.
Methods: A retrospective study of indoor records of 70 patients admitted over a period of 5 years at the Sir Sayajirao General Hospital (SSGH), Baroda, Gujarat, India, was carried out.
Results: A majority of patients were males ($n = 67$), the median age being 36 years. The median delay in presentation to the hospital was 11 h. Median TRISS score was 98.2%. There were three mortalities. Major wound infection ($n = 1$), intestinal fistula ($n = 1$) and multiple organ dysfunction syndrome ($n = 2$) were the noteworthy complications.
Conclusion: Arrow injury and its astute management is still relevant in this century. Delay in treatment and a poor TRISS score adversely affects survival. Optimal exploration, adequate mobilisation, minimising haemorrhage and repair are the building blocks of successful treatment.

Introduction

Arrow warfare and its resultant injuries is a rarity today due to the availability of a wide range of modern firearm devices. Arrows were the earliest and most effective long-range weapon for hunting and wars in ancient times. The history of arrow injuries and the evolution in their management over the ages has been vividly documented.[7] Isolated instances of these weapons being used for homicides and suicides are found in Western literature.[1,2] Though a number of studies on arrow injuries have been reported from Papua New Guinea,[4,5,15] only isolated case reports have emanated from India, Africa and Western countries.[3,6,10—14] This retrospective study was carried out with the aim of studying the clinical profile of patients with arrow injuries and analysing the problems faced in their management.

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Figure 1 An abdominal roentgenogram with the arrow in situ.

Patients and methods

A retrospective review of patient records extending over a period of 5 years from 1 January 1998 to 31 December 2002 was carried out and all 70 patients with arrow injuries, treated at the Sir Sayajirao General Hospital and Government Medical College, Baroda, Gujarat State, India, a tertiary care centre were included. All the patients had been referred from either the Primary Health Centres (PHCs) or the Community Health Centres (CHCs).

They were received at the trauma centre, clinically evaluated and managed by the surgical team on emergency duty. Patients with injuries over the trunk were subjected to chest and abdominal X-rays (Figs. 1 and 2) and abdominal ultrasonography (USG) while those with peripheral injuries underwent X-ray of the local part to rule out bony injuries. CTscan was not available.

Results

Seventy patients were treated for arrow injuries. The patient features are outlined in Table 1. Patients had chest, thoraco-abdominal, abdominal and limb injuries. There were no instances of injury to the head and neck. The different presentations of arrow injuries have been depicted in Table 2. Abdominal injuries were predominant ($n = 30$), while limb injuries were seen in only eight patients who had the arrows extracted before reaching the hospital.

Figure 2 Roentgenogram spine lateral view showing an arrow in situ.

Patients with respiratory distress had tube thoracostomy (TT) on clinical grounds. Eight patients

Table 1 Patient features

Total patients with arrow injuries	70
Gender	
Male	67
Female	3
Median age	36 years (range 18—65 years)
Median delay in presentation	11 h (3 h—10 days)
Arrow	
In situ	36
Extracted	34
Presentation	
Stable	64
Haemorrhagic shock	3
Respiratory distress	3
Median TRISS score	98.2% (range 80.6—99.4%)

Table 2 Presentation of arrow injuries

	Thoracic	Abdominal	Thoraco-abdominal	Limb
Number of patients	22	30	10	8
Arrow in situ	14	10	10	0
Lateral wounds	15	2	10	2
Anterior wounds	2	18	0	6
Posterior wounds	5	10	0	0
Subcutaneous emphysema	8	0	4	0
Pneumothorax	4	0	0	0
Haemothorax	4	0	0	0
Haemopneumothorax	14	0	10	0
Fracture ribs	17	0	4	0
Haemorrhagic shock	0	2	1	0
Respiratory distress	3	0	0	0
Prolapsed bowel	0	4	0	0
Prolapsed omentum	0	8	0	0

with thoracic injury who were clinically stable required TT. The rest of the patients underwent exploratory thoracotomy ($n = 14$), laparotomy ($n = 30$) or a combination of both ($n = 10$). Exploration was performed if there was an arrow/arrowhead in situ, more than 1000 ml of blood initially or more than 100 ml/15 min on TT, haemorrhagic shock, bowel or omental evisceration, bile leak, free intraperitoneal gas, peritonitis and sonographic evidence of solid organ injury. The arrowhead was not disturbed prior to surgery and was extracted only after complete exploration of the tract. In six patients, the arrowhead was impacted in the vertebral bodies.

Multiple organ injury was seen in 32 patients. Injury to hollow viscera was the most common ($n = 38$) followed by laceration of lung ($n = 20$). Table 3 shows the diverse injuries encountered and their management. Lung lacerations were sutured after debridement with 2—0 silk sutures. None of the patients had a prolonged bronchopleural leak. Incidentally, there were no injuries to the bronchial tree. None of the lung injuries were severe enough to merit either a pneumonectomy or a lobectomy, which would be indicated only in patients with injury to major pulmonary vasculature causing parenchymal devitalisation.

Table 3 Injuries and their treatment modalities

	Organ injuries	No. of patients	Treatment modalities
1	Laceration of lung	20	Debridement suturing
2	Diaphragm	10	Debridement suturing
3	Pericardium	1	Debridement suturing
4	Inferior vena cava	2	Suture repair
5	Liver	12	Suture repair over absorbable gelatin sponge
6	Stomach	8	Debridement suturing
7	Small intestine	10	Debridement suturing
		8	Resection and anastomosis
8	Colon	11	Debridement suturing
		1	Proximal colostomy with suture repair
9	Spleen	6	Splenectomy
10	Greater omentum	4	Suturing with ligation of bleeders
11	Mesentery	2	Suturing with ligation of bleeders
12	Retroperitoneal haematoma	4	No active surgical management
13	Pancreas	2	Suture repair
14	Kidney	2	Suture repair
15	Ureter	1	Suture repair over double J stent
16	Abdominal aorta	1	Suture repair
17	Axillary artery transection	2	End to end anastomosis
		2	Reversed saphenous vein grafting

Table 4 Mortality following arrow injury

No.	Type of injury	TRISS (probability of survival)	Injury admission interval	Organs injured	Surgical management	Treatment death interval	Cause of death
1	Abdominal	80.6%	18 h	Spleen Kidney	Splenectomy Suture repair	4 h	Pre-operative blood loss with persistent hypotension
2	Abdominal	83.5%	10 days	Small intestine	Suture repair	10 days	Intestinal fistula, septicemia, MODS
3	Thoraco-abdominal	86.5%	6 h	Right lung Diaphragm Inferior vena cava Liver	Debridement Suture repair Suture repair Suture repair	30 days	Pneumonia, septicemia, MODS

MODS: multi-organ dysfunction syndrome.

All patients treated for arrow injuries received a combination of antibiotics in therapeutic doses for a period of 7—10 days except in case of complications when the period was extended. A third generation cephalosporin, an aminoglycoside and metronidazole were the antibacterials used. Fifty patients required intra or post-operative blood transfusions (median 0.5; range 1—4). None of the patients received prophylaxis for prevention of deep vein thrombosis. Seven patients who had either thoracic or thoraco-abdominal injuries required post-operative ventilatory support. All patients who were explored for trunk injuries underwent active post-operative physiotherapy and early post-operative mobilisation.

Three patients succumbed to their injuries. Their presentation, management and cause of death are summarised in Table 4.In the patient with intestinal fistula, total parenteral nutrition could not be given because of financial constraints and reoperation was not performed on account of the poor nutritional status of the patient (Table 4). A 25-year-old woman in her third trimester who reported 22 h after injury in a stable condition without the arrow in situ. She delivered a stillborn baby within an hour of admission, underwent resection for multiple jejunal perforations and had an uneventful recovery. Except for a patient with major post-operative wound infection, the rest of the patients were discharged after 11—15 days (median 13 days).

Discussion

Arrow injuries are frequently treated at the Sir Sayajirao General Hospital Baroda, a university hospital in Central Gujarat, India, after being referred from the PHCs or CHCs. The PHCs are manned by two or three general duty doctors and have no facilities for major surgery. The CHCs have facilities for surgery but do not have qualified surgeons, anaesthetists or blood banking facilities most of the time. Hence, only in very rare instances are patients with arrow injuries over the extremities managed at these centres. After preliminary first aid, a majority are transported over a distance of 50—100 km by ambulance or by private vehicles to our hospital.

The patients are usually tribals who are drawn from a large, densely populated tribal belt bordering the three Western Indian states of Gujarat, Madhya Pradesh and Rajasthan. Cheaper, home-made bows and arrows form a major part of their armoury. The tribals hand craft the main skeleton of the bow and arrow using wood. The arrows are composed of two parts, the arrowhead and the shaft, with flights made of feathers at its posterior end. In contrast to the steel field tip and broad head arrowheads used in developed countries, those used by the tribals are of tapered and sharpened iron. Fig. 3 shows the different types of arrowheads

Figure 3 The different types of arrowheads extracted in the present series.

being used by the tribes of Western India. Though arrowheads of hardened wood, bone, stone and glass[4,5,8,15] have been mentioned in the literature, we have not come across any of these.

Ballistics of the different types of bows and arrows has been scientifically documented.[8] The penetrating and destructive effect of a projectile depends on its weight, velocity, cross-sectional area as well as sharpness.[9] The mechanism of injury is a combination of two sharp forces: penetrating action of a dagger and peripheral sharp cutting action of a knife. Laceration of tissues is minimal.[8] The external ballistic performance of an arrow is excellent due to its elongated shape and high sectional density, which enhances its capability to penetrate deeper. Arrows can cause diverse injuries with resultant morbidity and mortality.[3–6,10–15] Karger et al. found that external haemorrhage before extraction of arrow was seen only in large wounds caused by broad heads or on injury to major vessels and not with primitive arrowheads.[8] In our study, active external bleeding was seen in four patients with wounds in the axilla, where there was transection of the axillary artery. In the rest, external haemorrhage was minimal. This may be because tissue elasticity has the tendency to compress the wound track and the arrow in situ tends to exert an incomplete tamponade on the wound. This tamponade effect is very effective in arrow injuries to solid organs such as liver, spleen and kidney. However, it may not be that effective in case of injuries to hollow structures or blood vessels. The quantum of tissue injury and the rate of haemorrhage from arrow injuries are generally less than gunshot injuries.[5,8] Hence, unless vital structures such as the heart, great vessels or major vascular pedicles are injured, which may lead to rapid exsanguination, most of the patients with arrow wounds survive for a longer period without treatment. This may explain why one patient presented 10 days after injury.

More than half (n = 36) of the patients presented without an arrow in situ. This was because of a general tendency among the victims and their relatives to pull out the arrow at the first instance, failing which they would break off the wooden shaft. All the entry wounds were sharp and linear in contrast to broad heads, which cause star like or gaping wounds.[8] In stable patients, spiral CT may help in accurately defining the relations between the arrow and major visceral structures, thus facilitating its safe extraction.[12] MRI is preferred in case a wooden arrowhead is suspected.[5]

We did not encounter any case of myocardial injury or injury to the head and neck which have been reported in earlier studies.[4,5,11,13–15] No logical reason can be given for the absence of myocardial injury other than the assumption that such patients succumbed to their injuries before they could be provided medical help. We believe that better infrastructure and management at the referral centres would have saved some lives. However, we have no data to support this.

The treatment of arrow injuries depends on the site of injury, general condition of the patient, presence of arrow in situ and its depth of penetration. The arrowhead should not be disturbed prior to surgery and should be extracted after complete exploration of the track. Patients in whom an arrow has been extracted prior to admission are relatively easier to treat, while those with arrows in situ require additional care and skill in removing the arrow. Heavy instruments such as Kocher's or Robert's forceps are useful. An attempt at blind extraction is an invitation to disaster, more so if major vessels have been involved. Impalement of arrow into vertebral bodies and retro peritoneum is common (Figs. 2 and 4). While removing arrows, utmost care is necessary to prevent aggravation of internal injuries as well as injury to the operating surgeon by the sharp blades of the arrow. Rotation of the arrowhead during extraction is condemned, because it can aggravate internal injuries.[8] If neuro-vascular injury is suspected, proximal and distal mobilisation and control is required after exploration. Anterior intraperitoneal injuries mandate a laparotomy. For lateral wounds with arrow in-situ, a transverse abdominal incision is preferable because the deeply lodged arrow tends to anchor the abdominal wall, prevents its retraction and gives inadequate exposure of the viscera. Median sternotomy is essential when there is a para-sternal injury with likelihood of injury to

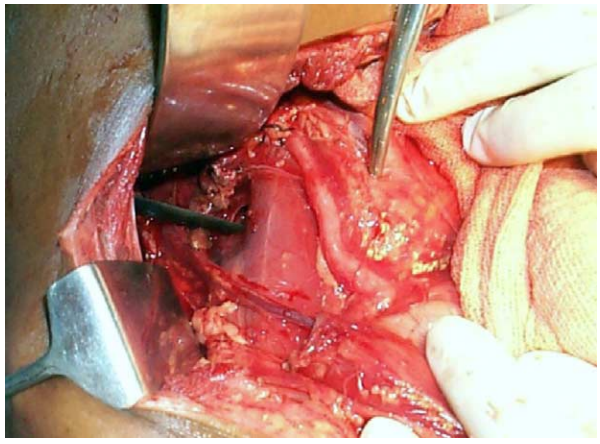

Figure 4 Intraoperative photograph showing an arrow embedded in the spine through the psoas major.

the heart and great vessels because it gives a better exposure.[5] Thoraco-abdominal injuries due to arrows are complex and invariably require exploration. Reparative rather than resectional surgery suffices for a majority of the visceral organ injuries (Table 3).

A wide range of complications has been cited in the literature depending on the site of arrow injury.[3–6,10–15] Though poisoned arrows have been mentioned in ancient literature,[7] none of our patients showed any clinical evidence of poisoning related to arrow injury. The common factors in all the three patients who died were an abnormal delay in presentation and a poor TRISS score (Table 4). Hence unless better facilities are developed in the referral centres to treat these injuries or improved transportation facilities are provided, occasional mortality will be encountered.

In conclusion, arrow injury and its astute management is still relevant in this century, more so in the third world. With the limited hospital setup, managing patients with arrow injury is a challenge. The general principles of trauma care should apply to all patients with arrow injury. Educating the tribals about the futility of pulling out arrows would be helpful. As time is of essence in the management, early and rapid transportation of the patients to hospital is necessary. A poor TRISS score reflects adversely on the survival of the patients. Optimal exploration, adequate mobilisation of structures, minimising haemorrhage, prevention of additional injuries and repair remain the building blocks of a successful treatment.

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