

# Vascular Injuries Caused by Tear Gas Shells: Surgical Challenge and Outcome

## Original Article

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## Abstract

**Background:** Tear gas shells are used to disperse the mob during any type of street protests. Vascular injuries due to tear gas shells have not been reported. The present study was undertaken to analyse the pattern, presentation, management and outcome of vascular injury due to tear gas shells.

**Methods:** Eighteen patients with vascular injury caused by tear gas shells from 1<sup>st</sup> Jan. 2008 to 31<sup>st</sup> Dec 2009 were studied. Patients with vascular injuries caused by causes other than tear gas shells were excluded from the study.

**Results:** All patients were treated with reverse saphenous vein graft as segmental loss was less than 2.5 cm. Wound infection was the most common complication, followed by graft occlusion. Amputation rate was 16.66%. Associated nerve injury occurred in 44.44% of the patients.

**Conclusion:** Tear gas shell injuries should not be taken lightly. They can cause injuries as serious as vascular injuries. Vascular injuries caused by tear gas shells require prompt revascularisation to improve limb salvage. Despite proper revascularisation, patients have significant morbidity and need proper rehabilitation in the follow ups.

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**Keywords** • Tear gas • vascular injury • saphenous vein

## Introduction

Tear gas shells are used to disperse the mob to prevent the law and order problems, which arise out of various issues all over the world including the state of Jammu and Kashmir. It is considered quite safe to use these shells for dispersing masses. However, we encountered very serious types of injuries, which had been caused by tear gas shells and were similar to those induced by other war weapons.

Vascular injury presents a great challenge to the emergency treatment team, because such injuries require urgent intervention to prevent loss of life or limb. Moreover, they are challenging since sometimes they present only with subtle or occult symptoms or signs. Historically, most patients who sustained serious arterial injury did not survive long enough to reach medical care provider. Those who made to a medical care provider generally had minor wounds. With advancement in the health care system and urbanisation of population, many seriously injured patients, even those with very serious vascular injuries such as carotid vascular injury, now arrive in the hospital and are salvaged.<sup>1,2</sup>

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The Present study was undertaken to analyse the pattern, presentation, management and outcome of vascular injuries induced by tear gas shells.

### Materials and Methods

The study was performed prospectively recruiting patients with vascular injury due to tear gas shells admitted to Sher-i-Kashmir Institute of Medical Sciences, Srinagar Kashmir, India from 1<sup>st</sup> January 2008 to 31<sup>st</sup> December 2009. There were widespread public demonstrations against the government during this period. Tear gas shells were used to disperse the mob during these demonstrations (figure 1). Very serious type of injuries did occur by these tear gas shells. A total of 202 patients injured by tear gas shells were presented to Emergency Department of the Hospital. Out of these numbers, 18 patients had vascular injury. Patients with vascular trauma caused by reasons other than tear gas shell were excluded from the study. Patients were initially resuscitated in the Emergency Department and a thorough clinical examination was done. All of the patients had severe signs of vascular injuries with extensive soft tissue damages. All of the patients were given third generation cephalosporins and aminoglycosides at the time of induction of anaesthesia. The injured vessels were exposed after controlling for proximal and distal bleeding. The extent of each injury was assessed. The

patients were revascularised using reverse saphenous vein graft. Thorough debridements of soft tissues were done. Heparin was instilled locally in every patient, and each patient also received anticoagulation therapy postoperatively in the form of clopidogrel and aspirin to decrease the chance of postoperative thrombus formation. Liberal fasciotomy was performed in most of the patients whenever deemed necessary on clinical assessment. All fractures were fixed before vascular repair while temporary vascularity was restored before fracture fixation. All patients underwent Doppler study postoperatively on the 10<sup>th</sup> postoperative day to ensure the patency of the vessels before discharge. The mean hospital stay was 15.4 days.

### Results

The patients' age ranged from 10 to 28 years (Mean 21.4 years). All of them were males. The patients were received in the Emergency Department within 20 minutes to 4 hours of injuries caused by tear gas shells. Mean delay was 2.3 hours. All the patients were revascularised within 6 hours of injury. Brachial artery was the most common artery injured followed by popliteal artery (table 1). All patients were diagnosed clinically as all of them had severe signs of vascular injury (table 1). All of them were managed by reverse saphenous vein graft. All the patients had extensive soft tissue damage in areas surrounding the injured artery (figure 2). All of them



Figure 1: Tear Gas Shell used to disperse the mob.

Table 1: The number and rate of presenting symptoms and involved arteries in patients with vascular injuries caused by tear gas shells

Presenting symptoms	Number(percentage)	Artery involved	Number (%)
Arterial bleed	11 (61.11%)	Radial/ Ulnar	2 (11.11%)
Shock	3 (16.66%)	Popliteal	6 (33.33%)
Absent peripheral pulse	2 (11.11%)	Brachial	8 (44.44%)
Expanding haematoma	2 (11.11%)	Anterior Tibial	2 (11.11%)

needed either grafting or flap cover for soft tissue defect. Associated skeletal trauma was present in 22.22% of the patients. Nerve injury was present in 33.33% of the patients (table 2). Half of them were repaired primarily. The next half was tagged only for future identification. Nine out of 18 patients developed postoperative complications. Wound infection was the most common (n=4, 22.22%) complication followed by bleeding from anastomosis site and (n=1, 5.55%) and thrombosis of the graft (n=1, 5.55%). Amputation rate was 16.66%. Four (22.22%) had associated fracture and 14 (77.77%) were without associated fracture. In two (50%) of the patients with associated fracture the limbs were salvaged, and in 13 (92.58%) of patients without fracture the limbs were salvaged. Ten patients had severe functional loss because of severe trauma to the neurovascular bundle.



Figure 2: Two ends of vessel are dissected free for reverse saphenous vein grafting.

Table 2: Other organ injuries associated with vascular injuries in patients\* exposed to tear gas shells

Associated injuries	Number and percentage
Skeletal fractures	4 (22.22%)
Nerve injuries	6 (33.33%)
Abdominal injuries	2 (11.11%)
Chest injuries	3 (16.66%)
Head injuries	3(16.66%)

\*Many patients had multiple injuries

## Discussion

Vascular injury due to tear gas shell injury is rare as the motive behind their use is to disperse the masses rather than to injure them. Most of vascular injuries are caused by penetrating injuries or road traffic accidents. Most of data on vascular trauma is from major wars such as World War I, World War II, Korean War, Vietnam War, Gulf War I and Gulf War II as well as low level civil wars in Middle East, Yugoslavia, Russian Republic, Kashmir and Central Africa.

Murphy in 1896 did the first successful end to end vascular anastomosis in man.<sup>3</sup> The successful repair of vascular injuries in Korean conflict is a pleasant contrast to the experience of World War II, because of substantial progress in techniques of vascular repair accompanied by the improvement in anaesthesia, blood transfusion and use of antibiotics.<sup>1,2</sup> Vascular injuries due to tear gas shells (figure 1) have a characteristic feature of being accompanied by gross destruction of surrounding soft tissues. The classical features of vascular injuries are usually obvious in these cases. Routine preoperative investigation is unnecessary. A cardinal operative principle in managing vascular trauma is to obtain proximal and distal control of the injured vessel before entering the surrounding haematoma.<sup>4</sup> In extremities as in neck, control is achieved using standard extensile vascular exposure techniques.<sup>5,6</sup> Once the proximal and distal control of vessel was achieved, irrigation of distal arterial tree is performed with heparinised saline (25-50 IU/ml) to remove or dislodge small thrombi from the main arterial tree. Embolectomy was done using Fogarty catheter in patients where there was no free flow due to thrombus formation after dissecting the two ends of the injured vessel. Reverse saphenous vein graft from contralateral limb was used in all of these patients as segmental loss was more than 2 cm in all cases. Systemic anticoagulation in the form of subcutaneous heparin was administered soon after the surgery and continued postoperatively for one week. It was followed by oral aspirin for 3 to 4 weeks. Popliteal vein repair was done as we and many others,<sup>7,8</sup> believe that the repair of popliteal vein will enhance the success of arterial reconstruction. However, popliteal vein has also been successfully ligated by some authors with no complications.<sup>9,10</sup> However, arterial repair preceded the venous repair to decrease ischemia time. As reported by many authors,<sup>11-17</sup> the significant factor, which is associated with increased limb loss, is the time lapse between injury and operation as there is progression of muscle ischemia, small vessel thrombosis that prevents successful outcome of the repair. In the present study, all patients presented to hospital within four hours of injuries, and they were revascularised within eight hours of injuries. The rate of limb salvage in the present study was 84.33%. Another important factor, which contributes to the limb loss, is the presence of associated fractures.<sup>14,18</sup> Associated skeletal fractures occurred in 20% of patients in the present study. Associated fractures had an impact on the amputa-

tion rate. In our study, wound infection was very high due to wound contamination and improper asepsis at the site of injury.

**Conflict of Interest:** None declared

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