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Original article

Terrorist attacks in Paris: Surgical trauma experience in a referral center

Thomas M. Gregory, MD, PhD^{a,*}, Thomas Bihel^a, Pierre Guigui^b, Jérôme Pierrart^a, Benjamin Bouyer^b, Baptiste Magrino^b, Damien Delgrande^a, Thibault Lafosse^a, Jaber Al Khaili^a, Antoine Baldacci^{a,b}, Guillaume Lonjon^b, Sébastien Moreau^b, Laurent Lantieri^c, Jean-Marc Alsac^d, Jean-Baptiste Dufourcq^e, Jean Mantz^e, Philippe Juvin^f, Philippe Halimi^g, Richard Douard^h, Olivier Mirⁱ, Emmanuel Masmejean^a

^a Upper limb and Peripheral nerve Unit, Department of Traumatology and Orthopaedic Surgery, Teaching European Hospital Georges Pompidou, Assistance Publique – Hôpitaux de Paris, University Paris Descartes, Sorbonne Paris Cité, Paris, France

^b Spine surgery and General Orthopaedics Unit, Department of Traumatology and Orthopaedic Surgery, Teaching European Hospital Georges Pompidou,

Assistance Publique – Hôpitaux de Paris, University Paris Descartes, Sorbonne Paris Cité, Paris, France ^c Department of Plastic and Reconstructive Surgery, Teaching European Hospital Georges Pompidou, Assistance Publique – Hôpitaux de Paris, University Paris Descartes, Sorbonne Paris Cité, Paris, France

^d Department of Vascular Surgery, Teaching European Hospital Georges Pompidou, Assistance Publique – Hôpitaux de Paris, University Paris Descartes, Sorbonne Paris Cité, Paris, France

^e Department of Anaesthesiology, Teaching European Hospital Georges Pompidou, Assistance Publique – Hôpitaux de Paris, University Paris Descartes, Sorbonne Paris Cité, Paris, France

^f Department of Emergency Medicine, Teaching European Hospital Georges Pompidou, Assistance Publique – Hôpitaux de Paris, University Paris Descartes, Sorbonne Paris Cité, Paris, France

^g Department of Imaging, Teaching European Hospital Georges Pompidou, Assistance Publique – Hôpitaux de Paris, University Paris Descartes, Sorbonne Paris Cité, Paris, France

h Department of Visceral Surgery, Teaching European Hospital Georges Pompidou, Assistance Publique – Hôpitaux de Paris, University Paris Descartes,

Sorbonne Paris Cité, Paris, France

ⁱ MOVEO Institute, University Paris Descartes, Sorbonne Paris Cité, Paris, France

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ABSTRACT

Background: On November 13th, 2015, terrorist bomb explosions and gunshots occurred in Paris, France, with 129 people immediately killed, and more than 300 being injured. This article describes the staff organization, surgical management, and patterns of injuries in casualties who were referred to the Teaching European Hospital Georges Pompidou.

Methods: This study is a retrospective analysis of the pre-hospital response and the in-hospital response in our referral trauma center. Data for patient flow, resource use, patterns of injuries and outcomes were obtained by the review of electronic hospital records.

Results: Forty-one patients were referred to our center, and 22 requiring surgery were hospitalized for >24 h. From November 14th at 0:41 A.M. to November 15th at 1:10 A.M., 23 surgical interventions were performed on 22 casualties. Gunshot injuries and/or shrapnel wounds were found in 45%, fractures in 45%, head trauma in 4.5%, and abdominal injuries in 14%. Soft-tissue and musculoskeletal injuries predominated in 77% of cases, peripheral nerve injury was identified in 30%. The mortality rate was 0% at last follow up.

Conclusion: Rapid staff and logistical response, immediate access to operating rooms, and multidisciplinary surgical care delivery led to excellent short-term outcomes, with no in-hospital death and only one patient being still hospitalized 45 days after the initial event.

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* Corresponding author at: Department of Orthopaedic Surgery, Teaching European Hospital Georges Pompidou, Assistance Publique – Hôpitaux de Paris, University Paris Descartes, Sorbonne Paris Cité 20, rue Leblanc 75015 Paris, France. *E-mail addresses*: tms.gregory@gmail.com, t.gregory06@imperial.ac.uk (T.M. Gregory).

Introduction

On November 13th, 2015, terrorist bomb explosions and gunshots in four bars and restaurants, and the Bataclan concert

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room occurred in Paris, France, with 129 people immediately killed, and 302 being injured [1]. The public hospital organization (Assistance Publique – Hôpitaux de Paris) had to manage an unusual flow of patients with gunshot injuries, with the need to mobilize all available pre-hospital units and referral trauma surgery centers [1]. Notably, gunshot injuries are rare in other countries such as France, in part due to a policy on firearms sales different to that of the US.

In contrast with the "scoop and run" strategy of mobile emergency units in various Western countries [2], severe trauma patients in France are managed by pre-hospital medical units (SAMU, service d'aide médicale d'urgence) allowing on-site medical advanced life support measures, prior to a transfer to referral centers for trauma surgery [3–5].

The Teaching European Hospital Georges Pompidou is one of the major trauma centers in Paris, with a Department of Traumatology and Orthopaedic Surgery divided in two units: one specialized in upper limb and peripheral nerve surgery, and the second one specialized in spine surgery and general orthopaedics. The medical staff encompasses: 15 senior surgeons (including 4 full professors, 1 associate professor, 7 assistant professors and 3 part-time practitioners), 9 residents and 15 medical students.

During usual night shift periods, two separate teams are set: one on duty, onsite, including a senior surgeon, a resident and a medical student (from one of the two units), and a second senior surgeon (from the other unit, on call). For the past two years, the average surgical activity during a night shift period included 3 surgical interventions. Overall, 10 gunshot injuries were managed annually in our institution during the same period.

We herein report on the adjustments made to the organization of our units, the initial management of patients referred to our center, the epidemiology of injuries observed in this patient series, and the subsequent radiological, surgical and critical care resources mobilized in this setting.

Materials and methods

From November 13th 2015 to November 15th 2015, all consecutive patients injured during the multisite terrorist attacks in Paris i) entering the emergency unit or the critical care unit of Teaching European Hospital Georges Pompidou (Paris, France), and ii) requiring surgery, were included in this study. Individual electronic medical records were retrospectively analysed, with a follow-up until December 31st, 2015.

The following outcomes were examined for each patient: age and gender; time of arrival, time of surgery, number and duration of surgical interventions; pre- and post-operative diagnoses; need for transfusion, antibiotics, and imaging procedures other than conventional X-rays; somatic and psychological follow-up; and persisting complications one month after admission. Descriptive

Table 1

Time of admission, time to surgery and duration of the first surgical intervention^a (n=22).

Time parameter	Results
Time of admission	
11:30-0:00	1 (4%)
00:00-1:00	0
1:00-2:00	7 (32%)
2:00-3:00	14 (64%)
Time to surgery: median (range)	11h37 (15 min-22 h48)
Duration of surgery: median (range)	1h42 (12 min-7 h45)

^a Four patients required more than one surgical intervention (median 1, range: 1-12).

statistics were used to analyze patients' characteristics (median, range, and percentages) using Microsoft Excel 2003.

Regarding adjustments made to the usual organization of the Trauma and Orthopedic Surgery Department and the management of medical and paramedical staff, a dedicated staff meeting was held on November 18th, 2015 to collect individual data on solicited and unsolicited interventions of the staff members during the study period.

The study was approved by the local review board, and conducted according to good clinical practice and applicable laws, and the declaration of Helsinki.

Results

Department organization and staff management

On November 13th, 2015, the information that critically injured patients would promptly be transferred by the SAMU to our institution was transmitted to the night shift team by phone calls from the SAMU regulatory crisis unit from 10:30 P.M.

From November 13th 10:45 P.M., the senior orthopedic surgeon on call, and another two senior orthopedic surgeons were contacted by the senior orthopedic surgeon on duty, as well as a plastic surgeon, in order to manage patients during the first night. As well, four scrub nurses were contacted by phone and joined the surgical team on duty during the same period.

In addition, four senior surgeons, three residents and three medical students – informed of the critical situation by phone, Whatsapp and Facebook groups or by TV channels – spontaneously joined our hospital from 11:15 P.M. on November 13th, aiming to strengthen the surgical team. Using Facebook, the medical students set a rotation planning for the following two days.

Overall, four operating rooms were used simultaneously and continuously for the first 48 h, including one room shared with vascular and visceral surgery teams.

Both chair professors held a staff meeting dedicated to the management of patients who had not yet undergone surgery on November 14th, 09:00 A.M., in order to prioritize surgical interventions, in view of clinical observations, and performed or pending imaging procedures. In addition, night shifts and team rotations were re-organized during this staff meeting, in order to allow each team member to take rest. Anticipating the increase of

Table	2		

Patients' characteristics (n = 22).

Characteristic	Observation
Age (years): median (range)	37 (24–60)
Gender: M/F (n)	12/10
Pre-operative diagnosis: n	
ULI	13
LLI	22
Visceral injury	3
TI	4
Facial injury	1
Occipital fracture (not requiring neurosurgery)	1
Post-operative diagnosis	
Soft tissue injury/wound debridement	14 LLI/7 ULI
Fracture/functional treatment	2 LLI/2 ULI/2 TI
Fracture/ORIF	5 LLI/2 ULI
Fracture/external fixation	1
Hand injury with tendon repair	2
Hemostasis Splenectomy	1
Gastrointestinal perforation	2
Hemopneumothorax	2
Foreign body	10

Abbreviations;: ULI, upper limb injury; LLI, lower limb injury; TI, thoracic injury; ORIF, open reduction fracture with internal fixation.

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surgical activity in the subsequent days, all elective orthopaedic surgery interventions initially scheduled on November 16th were cancelled, and postponed.

Given the expected need for blood transfusions, more than 100 Parisians spontaneously presented (from November 14th, 09:00 A. M.) to give blood at the Transfusion medicine facility of our institution, ensuring its ability to respond to the needs of the surgical team.

Finally, a twice daily staff meeting was held during the subsequent week in order to discuss each patient record in the post-operative setting, and discuss the need for iterative surgery. In addition, daily psychological follow-up was offered to the staff members from November 16th. The elective operating activity came back to normal from November 17th.

Patients' characteristics and outcomes

A total of 41 patients were primarily referred to our institution [1]. Twenty-four required surgery, of whom 22 were referred during the study period, the two remaining patients having been

managed in other Paris hospitals, before being transferred to our institution 3 days later.

Eleven patients (including three in whom mechanical ventilation had been initiated by the SAMU units) were admitted in the critical care unit, and the remaining 11 were initially admitted in the emergency room. No death upon arrival to hospital occurred.

The first admission was recorded at 11:38 P.M. on November 13th, and the last one at 02:55 A.M. on November 14th. The time of admission, median time to surgery and duration of the first surgical intervention are exposed in Table 1.

Patients' characteristics are described in Table 2. Overall, 7 patients required osteosynthesis by open reduction internal fixation (32%) mostly for lower limb fracture. External fixator (n = 1,4.5%) was used for a tibial comminuted fracture, functional treatment in another 30% of patients. In another patient with proximal humeral comminuted fracture, surgical resection of the humeral head was needed in the emergency context; an anatomical total shoulder prosthesis was implanted during a second intervention, 3 months later.



Fig 1. Fracture of the distal humerus caused by a bolt used in the bombing engines.

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Fig. 2. Gunshot injury of the forearm. Panel A: X-rays; Panel B: clinical lesion; Panel C: extracted bullet.

Soft-tissue injuries were treated by large wound debridement in 14 cases for lower limb injuries, and 7 cases for upper limb injuries. Fig. 1 illustrates a fracture of the distal humerus caused by a bolt used in the bombs. Fig. 2 depicts a gunshot injury of the forearm.

Eight patients underwent neurolysis (4 for sciatic nerve, 2 for ulnar and median nerves in the arm, and 2 for ulnar and median nerves in the forearm). In addition, two nerve sutures on sciatic nerve and one of the median and ulnar nerves were performed.

One patient required a free flap, and another one underwent a digital amputation.

In two cases, vascular bypass surgery was performed, one of the humeral vena and another one on the humeral artery.

Patients requiring visceral surgery underwent hemostasis splenectomy (n = 1), and colostomy (n = 2).

Nine patients (41%) underwent a body CT-scan, and another three (13.5%) required an angio-CT-scan of the limbs, due to suspected vascular injuries.

Regarding supportive care, 6 patients (27%) required blood transfusion, with a median of 2 red blood cells units (range: 2–32). Nineteen (86%) received antibiotics (amoxicillin plus clavulanic acid in all but one case, and amoxicillin in the remaining case). Due to the exposure to body fluids during the terrorist attacks, viral serologies (HBV, HCV and HIV) were proposed to 6 patients, of whom only one declined. To date, all performed serologies are negative. Anti-tetanic vaccination was updated in 3 patients

Table 3

Patients' outcomes (n=22).

Characteristic	n (%)
Surgery-related complications during hospitalization Postoperative palsy of radial nerve Infection of operatory site Allergic skin reaction to antibiotics or analgesics	1 (4.5) 3 (13.5) 2 (9)
Global outcome Alive Hospitalized (on Dec 28th, 2015) Returned at home Transferred to other hospital unit	22 (100) 1 (4.5) 18 (82) 3 (13.5)

(13.5%). Psychological follow-up was offered and accepted by all patients, with a median number of psychological consultations of 4 (range: 3–10).

Median duration of hospitalization was 9.5 days (range: 2–44+). Patients' outcomes are exposed in Table 3.

Discussion

In the context of multiple gunshot injuries with 22 patients referred to our center over a short period of three hours, our staff organization allowed the successful management of critical situations within the next 72 h.

Importantly, no death upon arrival to hospital occurred. However, neither neurosurgical nor complex cranio-facial injury patients were referred to our institution. Besides, we operated eleven patients with peripheral nerve injuries, referred to our Department due to its specific expertise. Although other authors [6] have reported that shrapnel injury is more destructive for nerve tissue than gunshot injury, we were not able to confirm those findings since a majority (21/22) of our patients had solely gunshot injuries.

The median time to surgery ranged from 15 min to 22 h48, depending on the severity of the injuries. Median duration of hospitalization was 9.5 days (range: 2-44+), similar to those observed following recent terrorist attacks in Western countries [7–9].

A particular attention was paid to supportive care measures, including infection prevention, and psychological follow-up.

As well, and notably, trust and communication i) between different jobs, including the nursing team and the sterile supply chain, and ii) between various surgical and medical specialties, were strikingly apparent during the study period, and the following weeks. Surgical interventions were performed without any delay (with respect to patients' conditions), all surgical specialties needed for patient care being on site even before request. Our administrative staff has also supported this effort, facilitating patients' registration, and helping on finding available beds in our institution.

Solidarity was observed not only among the members of hospital staff, but also with the Parisian population, who

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Fig. 3. Parisians queuing for blood donation in the hall of our institution, on November 14th, 2015.

spontaneously participated to blood donation, as illustrated in Fig. 3.

Finally, we would like to emphasize on the fact that the early reinforcement of the surgical staff might also have played a part in the favorable outcomes observed in the patients treated in our institution. New technologies and social networking played a critical role in facilitating communication, and anticipating the hospital staff crisis. Indeed, most assistant professors, residents and medical students who joined our night shift staff had been contacted (by on duty colleagues) using Whatsapp or Facebook groups.

Conclusion

Rapid staff and logistical response, immediate access to operating rooms, and multidisciplinary surgical care delivery led to excellent outcomes, with no in-hospital death and only one patient being still hospitalized 45 days after the initial event.

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Conflict of interest statement

The authors have no conflict of interest to declare.

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