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CASE REPORT

Patient Morbidity due to Sterile Zone Fire Outbreak during an Orthopaedic Trauma Surgery: A Case Report

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Abstract

Operating room fires are considered 'never events'; they are uncommon but can prove to be potentially damaging to the humans involved and the expensive operating room instrumentation. Research indicates that significant knowledge gaps exist in orthopaedic community relating to fire prevention, fire safety and fire management. A 24-year-old male patient with clavicle fracture was planned for surgical fixation. A nerve block procedure was performed. Skin preparation was done with 10% betadine scrub and surgical spirit. The surgical team performed skin incision, and superficial dissection was carried out using electrocautery. A fire broke out, and on noticing the fumes, saline was poured, drapes were removed and the authors observed charring of deeper linen and skin damage. A superficial thermal burn, greenish blue in colour (7 x 1.5 cms) located 1–1.5 cms above the surgical incision was evident (see Fig. 4). The event was later explained to the patient. The surgical scar was healthy, and burn margins became defined and darkish green blue. Dressing was done with megaheal ointment. The burn healed in 4 weeks. As these events are rare, a specific action protocol has not been orchestrated. With newer reports coming in, orthopaedic associations should work out a sustainable plan of action to minimize the occurrence of these events and the damage incurred. Training of orthopaedic and anaesthesia team and operating room personnel remains the most important step in countering a fire event, as more the helping hands, the better is the outcome. Maintaining a high vigil ensures timely action response to maintain patient safety and counter adverse events effectively.

Keywords Operating rooms · Fires · Surgical injuries · Accidental injury · Hazard control

Introduction

Operating room fires are considered 'never events' [1]; they are uncommon but can prove to be potentially damaging to the humans involved and the expensive operating room instrumentation. Research indicates that significant knowledge gaps exist in orthopaedic community relating to fire prevention, fire safety and fire management [2]. There is a need for orthopaedic surgeons to understand the risks of surgical fire in operating rooms and implement actions to reduce the risks [2].

It is estimated that 650 operating room fire incidents occur annually in the United States [1]. The operating theatre's oxygen-rich atmosphere is believed to be responsible for fire incidents in majority of cases and the use of alcohol-based skin preparation solutions carries significant risks of catching or spreading fire [3], with the latter fact being proven through various reported incidents and laboratory studies.

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Fire incidents can be described by a 'fire triangle' that has three necessary elements for the initiation of a fire, i.e., heat, fuel and an oxidizer [4]. The electrosurgical unit has been responsible for providing heat to ignite fires on most occasions. Very few reports mention patients getting injured during these fire events.

In this study, the authors present the case of a thermal burn in a patient being operated for clavicle fracture surgery due to direct fire contact, with clinical pictures, appropriate discussion and recommendations to check fire events for a safe orthopaedic practice.

Case Report

A 24-year-old male patient reported to the outpatient department following a road traffic accident. He was diagnosed with a clavicle fracture (see Fig. 1) and planned for an open reduction and internal fixation surgery. Under standard operating conditions, a nerve block procedure was performed to anaesthetize the operative area.

The operative area preparation was done with 10% betadine scrub and surgical spirit. Regular draping was done, with the drapes being secured using silk suture. The surgical team performed skin incision, and superficial dissection was carried out using electrocautery. The authors observed charring of drapes and smoke in the surgical field. It took some time for the surgical team to understand that the fire had broken out.

In panic and search for an appropriate sterile antidote, the authors could have relied on normal saline. Saline was poured generously in the surgical field. Further dissection was stopped, to evaluate the loss. The topmost drapes were charred (see Fig. 2) and were removed to evaluate the loss. Deeper linen had extensive charring, indicating more damage to deeper layers (see Fig. 3). A superficial thermal burn, greenish blue in colour (7 x 1.5 cms) located 1–1.5 cms above the surgical incision and along 2/3rd length of surgical incision was evident (see Fig. 4). Another round of

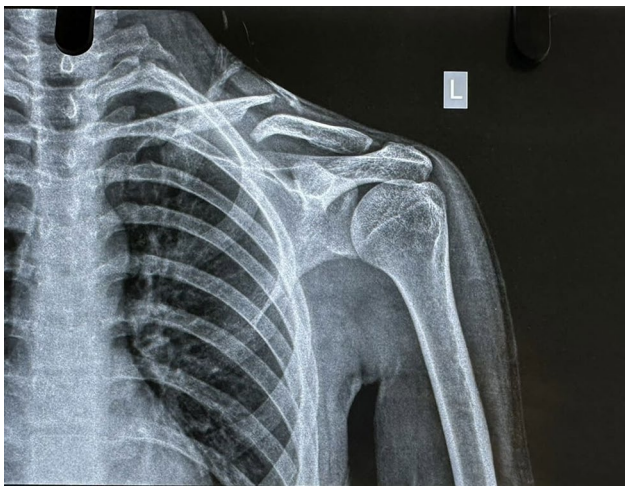


Fig. 1 Preoperative radiograph: clavicle shaft fracture—left



Fig. 2 Intraoperative clinical picture: charring of superficial linen (secured) and surgical wound



Fig. 3 Intraoperative clinical picture: extensive charring of deeper linen



Fig. 4 Intraoperative clinical picture: a superficial (greenish) burn patch and a secured suture line

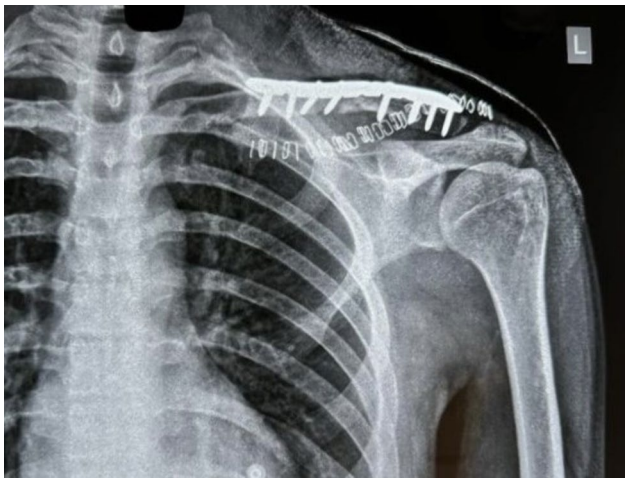


Fig. 5 Post-operative radiograph: i*n Situ* extra-articular locking plate (ORIF)—left



Fig. 6 Clinical picture: 1st dressing (POD 1): a dark green blue patch with well-defined margins and a satisfactory suture line



Fig. 7 Clinical picture: 3rd dressing (POD 12): healed burn patch and a satisfactory suture line

saline was poured over the burn patch with saline-soaked betadine dressing and re-draping to complete the surgery.

The surgical procedure was completed, and the patient was explained about the intraoperative event. Post-operative radiographs were satisfactory (see Fig. 5), and dressing was done the next day after surgery. The surgical scar was healthy, and the margins of the burn patch became defined, the colour was darkish green blue now, but it still seemed to be a superficial burn (see Fig. 6). Dressing was performed after a saline wash, and megaheal ointment was applied on the burn.

Dressing was performed on 4-day intervals; the burn was healing well but at a slower pace than the surgical scar (see Fig. 7). The patient was performing routine shoulder and elbow exercises from the next day after surgery. The sutures were removed on POD 14, and the burn took 2 weeks more and overall 1 month to heal (see Fig. 8). The patient performed well at later follow-ups.

Discussion

Fire events in intraoperative sterile fields are rare, and surgeons are caught unattended. There is no defined answer to fire events in the sterile zone. In orthopaedic practice, few reports of operative room and ward fire events exist, but the ones occurring in sterile intraoperative fields after commencement of surgery, directly damaging patients, have not been much reported before.



Fig. 8 Clinical picture: 4-week follow-up: healed burn patch and a satisfactory suture line

Flames are difficult to identify, probably due to bright illumination of the surgical field. In this case, authors could spot the fire only when smoke erupt with charred outer linen. By this time, most damage would have already occurred. The skin and deeper linen takes most damage as linen is soaked with surgical spirit remnants used for part preparation, which could also be the reason for the spread of fire. Skin being in direct contact suffers first, a sequence seen in our case.

At present, fire events not only lead to medico-legal challenges but can be a costly affair, considering the cost of expensive operation theatre machines and devices. Even if rare, we ought to develop ways of catching these intraoperative fire events early. Time is key and patient damage is directly related to the fire extinguishing time. Thus, the authors feel the need to have a defined sterile solution to counter fire events.

Fire outbreak and spread could be attributed to one of the many reasons. Most commonly, the re-use of electrocautery pens can be attributed to many fire incidents, as a break can lead to electricity leak and thus fire. Sometimes, a faulty cautery pad or faulty technique of application to patient's body can arbitrarily lead to either a thermal burn at the contact site or a fire at the pen tip due to a break in the circuit. Inflammable liquids like surgical spirits can easily catch and spread fire, thereby damaging the patient more. A thought arises, should inflammable liquids like spirit be avoided for surgical part preparation to reduce fire incidents.

Even if risky, electrocautery adds onto surgeon's comfort, and replacing or substituting it may not be a convenient solution to the problem, but avoiding the re-use of disposable electrocautery pens may surely help reduce these incidents. Replacing the flammable surgical spirit, with a sterile fluid competent enough but inflammable, is the need of the hour, and this may be the answer to the spread of fire. Regular operation theatre lights are known to increase the ambient temperature [5], which could potentially spark fires; instead, using newer 'cool' operation theatre lights can help reduce the surgical field temperature and thus fire occurrences. A thorough explanation of the event and responsible treatment surely helps settle patient's grief and damage.

As these events are rare, a specific action protocol has not been orchestrated. With newer reports coming in, orthopaedic associations should work out a sustainable plan of action to minimize the occurrence of these events and the damage incurred. Training of orthopaedic and anaesthesia team and operating room personnel [1] remains the most important step in countering a fire event, as more the helping hands, better is the outcome.

In the present study, the authors investigated the fire event and found that a sterilized (ethylene oxide) electrocautery pencil was used, and a break in insulating lining just near the pencil attachment site was noted. The operating surgeon recollected using copious amount of surgical spirit as is the practice in most healthcare facilities and thus the drying could have been inadequate, which could have led to the rapid spread of fire over the skin and deeper linen charring. The operating theatre had regular (non-LED) operating lights, which could have increased the ambient temperature and thus favoured the occurrence of a fire event.

Few working discipline changes were ensured to prevent such incidents and be prepared to efficiently counter such events in the future, such as discarding electrocautery pencils once used; performing quality check of electric sockets and electrical machines; using chlorhexidine gluconate handrub for surgical site preparation; ensuring proper drying of surgical field prior to making an incision, a primary responsibility of the operating surgeon; installing cool (LED) operating lights; adding 1-L vessel for holding normal saline to the operation trolley; installing fire extinguishers (compact) in the operating theatre; training operating room personnel on safe cautery plate application and installing dedicated voltage stabilizers in operating rooms.

Maintaining a high vigil and performing mock drills ensure timely and effective counter response to these sudden adverse events. Routine maintenance of electrical equipment

ensures proper function and reduces unnecessary electrical events. These steps will surely enhance patient safety and reduce medico-legal load for all practices. An electrical/fire safety checklist was introduced later into our practice.

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Data availability De-identified data may be requested with reasonable justification from the authors (e-mail to the corresponding author) and shall be shared after approval as per the authors' institution policy.

Declarations

Conflict of Interest The authors have no financial or other conflict of interest to declare and no financial or other relationships leading to conflict of interest.

Ethical Standard Statement This article does not contain any studies with human or animal subjects performed by the any of the authors.

Informed Consent The work was done at Santosh Medical College & Hospital, Ghaziabad. Informed consent was obtained from the patient to publish this work.

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