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Use of corrugated rubber drain to protect important structures during orthopaedic surgeries

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Abstract
Background: Important structures lying in the vicinity of surgical field are at risk of injury during surgical procedures. Such injuries are common during orthopaedic procedures and lead to major disability in patients. There can be multiple factors leading to intra-operative injuries to the structures. One factor leading to such injuries is application of various materials around these structures to protect them, which may cause undue traction over these structures.
Methods: We conducted a study in 50 patients operated for different fractures and used corrugated rubber drain to protect vital structures (nerves and vessels) during various surgical procedures.
Results: We observed that none of our patients suffered from intra-operative injury to the important structures.
Conclusion: Our aim is to introduce the use of corrugated rubber drain to protect vital structures during various surgical procedures. Although, a thorough understanding of anatomy, meticulous dissection and appreciation of pathoanatomy in surgery is of utmost importance to reduce the risk of iatrogenic injuries.

Keywords: iatrogenic, orthopaedics, corrugated rubber drain (CRD), nerve injury

Introduction
Surgical procedures carry a lot of risks depending on the surgical site. Injuries to the neurovascular structures is amongst one of the important complications [1].
Data from various studies shows that incidence of nerve and vascular injuries in trauma can range from 2% to 3% [2, 3]. Disturbed anatomy in cases of trauma leads to an increased risk of damage to vital structures. Anatomical planes are disturbed due to edema, hematoma or scarring making surgical procedures more difficult. Furthermore, manipulation of bones and insertion of reduction instruments which require the use of power tools, instrumentation and insertion of implants, also pose an additional danger to the surrounding structures.
Nerve and vessel injuries cause pain, paralysis, loss of protective sensation and may even lead to amputation of the involved limbs. These injuries adversely influence the outcome of the index procedure and may result in disability to patient, litigation, increasing the financial burden on surgical services.
Structures may be injured during trauma or during surgical stabilization of fractures during open reduction and internal fixation when normal anatomical landmarks are masked by swelling or there is a breach in safe corridors. In open treatment of fractures, there is more danger for injuries to neurovascular structures [4, 5].
Also, the use of power tools and instruments like k-wires, pins, drill bit, retraction by levers or retractors, application of implants or use of diathermy can lead to such injuries with a possibility of structures being injured by direct penetration, tethering, wrapping or heat generated by power tools and diathermy [4, 5].
Multiple methods are described to protect the nerves and vessels from being injured during surgeries. Commonly employed materials include use of glove sleeves, nasogastric tube, gauze pieces, low-thickness elastic tape or low-thickness latex tapes [6].
We employed the use of 250 mm X 25 mm size corrugated rubber drain (CRD) to protect nerves and vessels during surgical procedures.

Our aim is to introduce the benefits of the use of CRD to protect vital structures from perioperative injuries caused during surgeries.

A good knowledge about the anatomy is of utmost importance in protecting neurovascular structures from being injured. A thorough evaluation in preoperative period is important to identify the predisposing conditions which may lead to such injuries.

Per-operatively, proper positioning of the patient, use of protective padding, careful application of regional blocks under guidance and careful application of tourniquets with proper pressure are important components of care.

Materials and Methods

Patients undergoing elective open surgeries in the department orthopaedics at Shri Mahant Indiresh Hospital, Dehradun for fracture acetabulum, fractures of distal humerus and humeral shaft fractures were selected (Table 2). Study was conducted in 50 patients from January, 2021 to July, 2021.

Surgeries were performed using standard operative steps. After dissection and isolation of neurovascular structures, a 250 mm X 25 mm size corrugated rubber drain (Figure 1) was used to secure and protect the isolated nerves and vessels in vicinity of surgical field. Sciatic nerve, femoral artery in acetabulum surgeries, ulnar nerve in distal humerus surgeries and radial nerve in humerus shaft surgeries. Once the structure is protected with drain, two ends of corrugated rubber drain were sutured on itself (Figure. 2) and a small artery forceps was attached at its ends. Structures were retracted during various surgical steps using this drain. This can be slided near the working sites (Figure 3, 4). CRD was utilized to manipulate the structures during various steps of surgery. After implant fixation, CRD is safely removed. Before closure, it was ensured that there is no other factor causing nerve compression or bleeding from vessels was checked. Post operatively, distal pulses were examined and neurological evaluation respective to nerves exposed at the surgical site was performed in all the patients on subsequent follow-up. Maximum time for the recovery from effect of regional block was taken as 12 hours and clinical examination made after that was taken into consideration.

Parameters for assessment of vascular injuries was the measurement of saturation in the toes and fingers and status of distal pulses in the limb and outcome of nerve injury was assessed on the basis of functions of nerve affected (sensory, motor, or combined). Injury to a motor nerve results in loss of functions in supplied muscles, whereas injury to a sensory nerve results in sensory loss in the area of nerve distribution. [7][8] Motor functions (respective to the muscles supplied) of the nerves were tested respective to the muscles supplied, using Manual muscle testing as per Medical Research Council grades and Sensory modalities (Touch, Pain, Temperature, vibration and two point discrimination) were tested to assess sensory functions. [9]

Table 2: Number of cases operated and structures protected in various surgeries

Surgery performed	Structures Protected	Number of Cases
Acetabulum Fracture	Sciatic Nerve Femoral vessels	15
Distal Humerus Fracture	Ulnar Nerve	25
Humeral Shaft Fracture	Radial Nerve	10

Fig 1: Corrugated Rubber Drain of size 250mm X 25mm

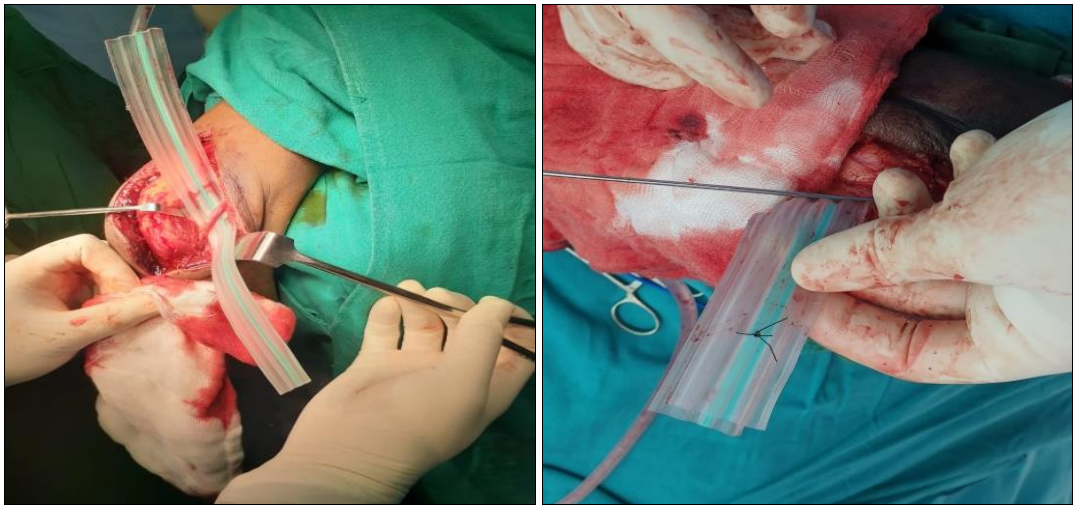

Fig 2A: Corrugated Rubber Drain placement around the Ulnar nerve during surgery; 2B- Drain secured with sutures at the end

Fig 3: Corrugated rubber drain placed around radial nerve in fracture humerus surgery with artery forceps at drain ends

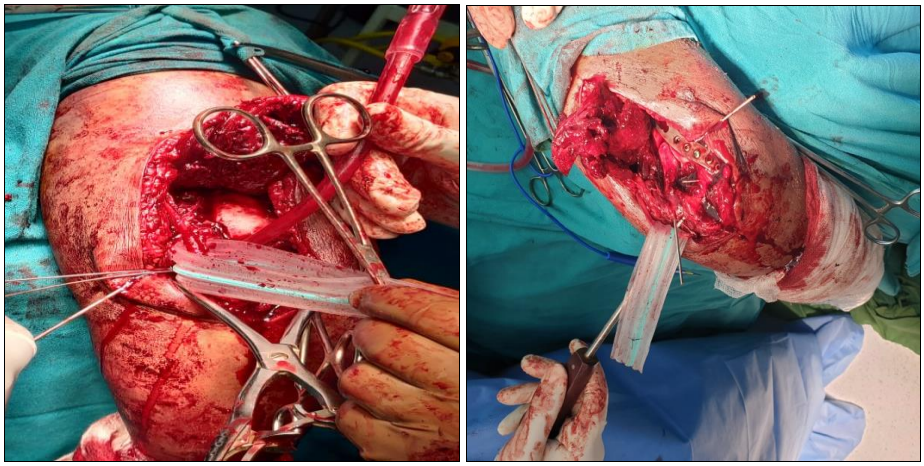

Fig 4A, 4B: Corrugated Rubber drain protecting structures during instrumentation

Fig 5: Corrugated Rubber drain protecting Sciatic nerve during instrumentation in acetabulum surgery

Results

Total of 50 patients with no neurovascular injury were included in the study. The age of patients was from 26 to 70 years. 15 patients were operated for acetabular fractures, 25 were operated for distal humerus fractures and 10 were operated for humerus shaft fractures. On post operative evaluation of the neurovascular structures protected during open surgical procedure, none of the patients were found to have signs of injuries related to the structures protected.

Discussion

Neurovascular injuries are commonly associated with orthopaedic procedures. The potentially devastating nature of these injuries and very less mention of a safe technique for prevention of such injuries in literature makes it a topic of interest. Many possible risk factors for intra-operative injuries can be there, instrumentation during orthopaedic surgeries being the most important. Disturbed anatomy in cases of fractures leading to difficult open procedures in trauma cases, further poses more danger. Various techniques are employed by different surgeons to protect nerves and vessels during surgeries but nothing has been defined clearly in literature.

This technique of utilization of CRD of size 250mm X 25mm for protection of vital structures is innovative in form as CRD being thicker than previously used materials protect neurovascular structures from getting tethered or wrapped up with instruments (like k –wires, drills, placement of plates and screws). CRD being firm than the conventionally used materials decreases the chance of structures getting wrapped up. Also, it protects from thermal injuries caused by the use of diathermy or drill bits. CRD being wider than previously used materials, prevents acute angulation of structures during retraction and decreases chances injuries due to traction.

Power tools can be used adjacent to the CRD without any risk of structures being damaged. Using this technique, position of structures can be manipulated easily and they can be lifted away from the bone which helps in easy placement of implant over bone surface, thereby preventing damage.

Other advantages of CRD include its easy availability, cost effectiveness.

Possible limitations of CRD use could be a need of more dissection for the placement. Another possible disadvantage could be its limited utility for small structures.

Some precautions to be employed while using this technique include use of small artery forceps at the ends as heavy artery forceps can lead to excessive traction. Surgeons should be aware of the inherent surgical risks and anatomy. However,

this technique cannot override the sound knowledge of anatomy and meticulous dissection but a judicious use of corrugated rubber drain can serve as a great tool to prevent iatrogenic neurovascular injuries.

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