Radial Nerve Palsy With Fracture Shaft Of The Humerus Treated With Early Limited Nerve Exploration And Internal Fixation

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Abstracts: Background and Objective: Radial nerve injuries associated with fractures of the humerus are the most common peripheral nerve injuries in long bone fractures. Management of these injuries remains controversial. Strong convictions for and against either line of treatment - conservative or operative can be drawn from the literature. This study evaluates the role of early limited exploration in these injuries. Methods: Sixteen patients with radial nerve palsy with fracture shaft of humerus treated with open reduction and internal fixation with plates were studied. Follow up of the patients was done with regard to intraoperative findings and pattern of recovery. Results: Radial nerve continuity with spontaneous clinical recovery was seen in all of our cases. The average time for onset of recovery in our study was two weeks for neurapraxia and 22 weeks for axonotmesis. The average time for complete recovery was five weeks for neurapraxia and 30 weeks for axonotmesis. 88% of our cases showed excellent and 12% showed good results. Conclusions and interpretation: Limited early nerve exploration of radial nerve is a reliable option while performing internal fixation for both primary as well as secondary radial nerve palsy with fracture of shaft of humerus. [Jain D et al NJIRM 2012; 3(5) : 8-13]

Key words: Exploration, Fracture shaft humerus, Radial nerve palsy

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Introduction: Radial nerve injuries associated with fractures of the humerus are the most common peripheral nerve injuries in long bone fractures[1]. Injuries to the radial nerve result in significant motor impairment of the arm and the wrist. With the loss of wrist extension, the ability to grasp is significantly reduced leading to a serious handicap. The radial nerve may be injured by the force that fractures the humeral shaft, directly with contusion or laceration by a spur or by traction when the bone ends are forcibly separated. The anatomical relationship of the radial nerve to the shaft of the humerus plays an important role[2]. The radial nerve travels across the spiral groove in the shaft of humerus separated from it by a layer of fibres of triceps. When the radial nerve pierces the lateral intermuscular septum to enter the anterior compartment of the arm, it is relatively more fixed and susceptible to injury.

Management of radial nerve injuries with fracture of the humerus remains controversial. Strong convictions for and against either line of treatment conservative or operative can be drawn from the literature[3]. Opinion also differs regarding the time of operative intervention whether to go for early or delayed repair. Clear guidelines regarding the management of fracture shaft of humerus are also not available adding to the dilemma[3].

Radial nerve injury associated with a fracture of the humerus no doubt poses a challenge to the treating surgeon. This study evaluated the results of treating these injuries with open reduction and internal fixation with plates and limited early exploration of the radial nerve. The purpose was to study surgical findings and pattern of recovery and correlate them so that they can be understood well and better results can be obtained.

Materials and Methods: This is a retrospective observational study carried out in the Department of Orthopaedics, Dayanand Medical College and Hospital, Ludhiana, a tertiary care centre catering to a city of three million people. Patients of fracture shaft humerus with radial nerve palsy treated with open reduction and internal fixation with plates from September, 2008 till December, 2010 were included in the study after obtaining patient consent and permission from Ethics Committee.

The indications for open reduction and internal fixation of fracture shaft of humerus included failure of closed reduction, distraction of fracture ends, polytrauma patients, complex fracture pattern, open fractures, ipsilateral forearm fracture, secondary radial nerve injury following manipulation and non union. Anterolateral approach was used for proximal and middle third fractures and posterior approach for distal one third fractures. Limited exploration of the nerve was carried out to look for integrity of the nerve around the fracture site. The nerve was freed if entangled between fracture ends was done and dissection was limited to an extent which allowed plate fixation. Narrow low contact dynamic compression plate (LC-DCP) or locking compression plates (LCP) were used to fix the fractures. Fractures of the humerus with radial nerve injuries that were internally fixed initially and operated later for non union, implant failure or non recovery of the radial nerve were not included since the native status between the fracture and the nerve had been disturbed.

All patients with fracture shaft humerus treated with plate fixation were extracted from the operation room register. The discharge card of these patients was retrieved from the digital record maintained in the department. Those patients with radial nerve palsy associated with fracture shaft of the humerus were selected for the study. The complete medical record of indoor stay of these patients was retrieved from the central record office of the hospital and follow up data of monthly outpatient visits was recorded. These patients were followed up for a minimum of one year or till the time for recovery of radial nerve whichever was later. The parameters studied were age, sex, mode of injury, site of fracture whether proximal, middle or distal third of shaft, pattern of fracture whether transverse or oblique or spiral and whether closed or open injury. The time of onset of recovery, time of full recovery, pattern of muscle recovery whether simultaneous or sequential and sensory involvement were also noted. Sakellarides' scale was used to evaluate the function of radial nerve which uses extension of wrist, fingers and thumb along with muscle coordination to grade radial nerve recovery[4]. Union of the fracture and method of plating were not studied as parameters in this study.

Electromyography (EMG) of brachioradialis muscle was done to predict the recovery if the patient did not improve after waiting for requisite time interval commensurate with the distance between the site of nerve injury and level of supply of brachioradialis.

Results: Out of 168 fractures of humerus shaft fractures treated with plating, there were 18 patients with associated radial nerve palsy. Two patients were lost to follow up before recovery of radial nerve function leaving 16 patients (12 men and four women) with a mean age of 36 years (range 19 - 60 years). Road side accidents were the cause of 11 patients, domestic fall in 4 cases and gunshot injury in one case. The fracture occurred in the middle one-third of humerus shaft in nine cases, the distal third was involved in six and proximal third in one cases. The fracture pattern was transverse in six cases, oblique in four, spiral in five and segmental in one. Associated communition was seen in nine cases. Two fractures were open injuries, both of which were Gustilo and Anderson Grade IIIA injuries. In our series, six patients had concomitant injuries to other systems with head injury observed in maximum number of cases (n=4). In four cases, other long bone fractures were also present out of which ipsilateral femur fracture was present in two cases and ipsilateral forearm fracture in two cases. Fourteen of the nerve palsies were primary manifesting just after the trauma and two were secondary occurring after manipulation. Complete motor power loss was seen in 14 of the patients and two had incomplete motor power loss. Sensory loss was seen in seven cases.

Nerve was found to be in continuity in all the cases. In four cases, it was entangled between the fracture fragments and was extricated. Nerve contusion was seen in seven cases and in rest no abnormality was found. No epineurolysis or neurolysis was done.

All the cases followed up showed recovery of radial nerve function. In ten cases, simultaneous onset of recovery was seen in all muscle groups suggestive of neurapraxia. The average time of onset of recovery in this group was 14 days (range one day to four weeks) which was complete and full at an average of five weeks (range three to ten weeks). In six cases, the onset of recovery was at an average of 22 weeks (range 12-36 weeks) suggestive of axonotmesis. Motor march with distal progression of muscle reinnervation was seen in this group. The average time for completion of recovery in this group was 30 weeks (range 20–44 weeks). Included in this group were two cases of secondary nerve palsy and one case of partial nerve involvement which progressed to complete involvement after surgery. According to Sakeraillades scale, 14 patients showed M4 (excellent) grade and two showed M3 (good) grade.

Discussion: Radial nerve, the largest branch of the brachial plexus, is predisposed to injury because of its anatomical relationship to the humerus[2]. Whitson in his cadaveric study challenged the view that spiral grove demarcates the lateral and medial heads of triceps brachii and that radial nerve passes between these two heads[5]. According to him, the radial nerve traversed the triceps at such a depth that it was nowhere in contact with the humerus and the radial nerve was separated from it by fibers of medial head of triceps and this mass of muscle protected the radial nerve from injury by sharp body edges. The incidence of the radial nerve palsy with fracture shaft of humerus has been reported from 1.8% to 15% in various studies making it the most common nerve injured in long bone fractures[3].

Our patient cohort represents the subset of population presenting at a tertiary care hospital in an urban setting. Majority of injuries are road side accidents with complex fracture patterns accounting for 62.5% of cases which is due to high velocity trauma. The mean age of 36 years in our study with predominance of males and a high percentage of concomitant injuries also supports this assumption. However, there were two cases of males less than 35 years sustaining this injury after domestic falls. This raises the concern of increased prevalence of osteoporosis in younger population. 56% of the fractures involved middle one-third of humeral shaft and 37% in distal third which is in accordance with the systematic review of these injuries by Shao et al[3]. Fracture pattern was transverse in 38% cases, oblique in 25%, spiral in 31% and segmental in 6% cases corresponding with the study of Shah et al[6]. Comminution and butterfly fragments were seen more in spiral fractures. All the spiral fractures were seen in lower one third of humeral shaft producing a Holstein-Lewis syndrome picture.

Secondary nerve palsies were seen in 12% of the cases which is less than that reported by Lewis et al (60%) but in concordance with the study of Shah et al[6,7]. These were seen in spiral fractures of the distal one third of humerus shaft associated with a butterfly fragment. Incomplete palsies were seen in 12% of the cases and all these palsies were seen in transverse fractures.

Sensory deficit was seen in 43% of the cases. It bore no relation to the level of the fracture, associated motor deficit, the pattern of the fracture and the eventual recovery. Pollock et al have also reported similar results[8]. It is therefore a poor parameter for evaluation of radial nerve function.

Spontaneous clinical recovery was seen in 100% of our cases with all nerves found to be in continuity. This is higher than the overall reported incidence of spontaneous recovery, which has been reported at 88% in study by Shao et al[3]. Most of the cases of non recovery of the radial nerve in literature have been due to nerve lacerations following open fractures. Our series had only two open fractures explaining this variance. 62% of the cases showed recovery consistent with the pattern of neurapraxia while 38% of the cases showed recovery between indicating axonotmesis. There was no study in literature differentiating the recovery pattern in this way. The systematic review by Shao et al reports the average time for onset of recovery as 7.3 weeks as compared to two

weeks for neurapraxia and 22 weeks for axonotmesis in our series[3].

The average time for completion of recovery in our study was 5 weeks for neurapraxia and 30 weeks for axonotmesis. The reported incidence in literature is 6.1 months (3.4 to 12) by Shao etal[3]. 88% of the cases that recovered showed an excellent recovery according the Sakellarides scale while 12% (n=2) showed a good recovery, both of which were in the axonotmesis group.

All the cases showed the radial nerve to be in continuity after limited exploration. It was contused and was found entangled in fracture fragments in 25% of the cases and nerve contusion was seen in 43%. No surgical repair or neurolysis of the radial nerve was needed in any of the explorations. Thus, an extensile approach for radial nerve exploration is unnecessary and nerve exploration best carried out while performing plate fixation.

The management of radial nerve injury with fracture shaft of humerus remains disputed. Two lines of management – conservative or exploration, either early or late have been advocated to approach these injuries. Both the approaches have their merits and demerits.

Authors favoring early intervention cite a variety of advantages –

- Stability of the fracture reduced and fixed internally protects the radial nerve from further trauma.
- The damaged nerve can be separated from developing scar and callus.
- Examining the exposed injured nerves clarifies neurological prognosis and thus facilitates decision regarding neurorrhaphy or tendon transfers.
- Shortening of the humerus to facilitate nerve repair is better done before fracture healing is complete.
- Early operation is technically easier and safer.
- Functional nerve recovery is more complete and constant[9-11].

- Authors favoring conservative and expectant approach also give their own advantages:
- This approach avoids unnecessary surgery in those patients who would spontaneously recover neurological function.
- It avoids attendant risk of anesthesia, wound infection, osteomyelitis, delayed union, non-union and iatrogenic injury to the nerve.
- It is easier to deal with the nerve when the fracture is healed, the delay allows the neurilemmal sheath to thicken thus facilitating repair if neurorrhaphy is needed.
- The abundant callus does not preclude complete nerve recovery if the nerve is engulfed.
- Nerve recovery is just as good if you delay rather than operate early[6,8,12-15].
- Clear guidelines for the treatment of fracture shaft of humerus have also not been elucidated.

Conservative treatment using plaster splints or hanging casts, the sugar tong splint; or use of functional bracing such as the Sarmiento brace have been shown to give satisfactory results. This is because upto 3 cm of shortening and 20 to 30 degrees of varus, anterior or rotational deformity of the humerus can be accepted due to adjustment at the shoulder joint[16]. However, the risk of non-union remains, which has been reported in one in 10 conservatively treated patients[8]. The absolute indications of open reduction and internal fixation include complex and displaced fractures, Type II and III Gustilo open fractures, polytrauma or high energy trauma, ipsilateral forearm fractures (floating elbow), nerve injury(secondary radial nerve palsy, brachial plexus injury), serious vascular injuries, bilateral shaft fractures, segmental fractures, fractures with axial distraction, pathological fractures, and delayed or nonunions[17]. Surgery has also been recommended for for patients with Parkinson's disease or with only one functional arm, and for obese patients[18]. A Cochrane review was done to assess and compare the effects of surgical versus non-surgical intervention for non-pathological fractures of the humeral shaft in adults by

analysing randomised and quasi-randomised controlled trials comparing surgical and non surgical methods of treating humerus shaft fractures[16]. After searching the literature, this study found that there were no studies that matched this criterion, thus reflecting the lack of guidelines in treating humerus shaft fractures.

A systematic review of studies dealing with radial nerve injuries with fracture shaft of humerus was done by Shao et al in 2005[3]. It included 35 papers with 1045 patients and reported prevalence rate of 11.8%. The overall rate of recovery was found to be 88.1% (921 of 1045), with spontaneous recovery in 70.7% (411 of 581) in patients treated conservatively. There was no significant difference in the final results when comparing groups which were initially managed expectantly with those explored early. We support the view that expectant approach is the favourable method when treating these injuries as the chances of finding a surgically treatable lesion are very less. Expectant approach should definitely be followed in a patient in whom the fracture of the humerus is being treated conservatively. However, it also brings forward the point that the decision regarding exploration is dictated by the modality of treatment of humerus fracture rather than the associated radial nerve injury. The incidence of high velocity injuries has risen sharply in the last three decades with complex fractures, multiple fractures and polytrauma cases being more common. More and more humerus fractures are seen in obese individuals and in the elderly population, both of which are relative indications for operative treatment. New modalities of treating these fractures including locked plating, locked nails and minimally invasive techniques have decreased the complication rates associated with the surgical management[19]. All these factors have led to an increase in the number of patients with fracture shaft of humerus treated with internal fixation. Therefore, we propose that it is rational and safe to carry out limited early exploration of the radial nerve while doing fixation of the humerus fracture as it leads to a more predictable result.

Conclusion: Limited early nerve exploration of radial nerve is a reliable option while performing internal fixation for both primary as well as secondary radial nerve palsy with fracture of shaft of humerus. Expectant treatment is indicated in injuries undergoing conservative treatment for fracture of the humerus. However, the key to answering this problem lies in establishing evidence based guidelines for treating fracture shaft of the humerus.

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