

Supraclavicular Neuropathy after Surgical Treatment of Clavicular Fractures: Comparison of Two Incisions

Supraklavikulární neuropatie po chirurgickém léčení zlomenin klíční kosti: porovnání dvou operačních přístupů

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ABSTRACT

PURPOSE OF THE STUDY

To compare the clinical results of clavicular fractures operated by superior locking plate using either horizontal or vertical incision by physical examination and nerve conduction tests.

MATERIAL AND METHODS

Between January 2010 and January 2013, 63 patients with displaced midshaft clavicle fracture were treated with superior locking plate (22 female, 41 male) with either horizontal (n = 38) or vertical incisions (n = 25). Mean interval between trauma and surgery was 3 days (1 to 8 days). Electrodiagnostic tests were performed to 15 patients who felt numbness across their shoulder or chest and ASES test was performed to each of the patient 12 weeks postoperatively. IBM SPSS Statistics 22 (IBM SPSS, Türkiye) programme was used for statistical analysis. Student t-test was used for comparison of normally distributed parameters (quantity) and continuity (Yates) test was used. $p < 0.05$ was accepted to be statistically significant.

RESULTS

8 patients of the horizontal incision group and 7 patients of the vertical incision group described numbness across their shoulders. 14 patients had abnormal sensorial electrodiagnostic findings. Comparison of electrodiagnostic findings did not reveal any statistical significance. The mean ASES score of the affected shoulder was 76.39 ± 1.20 in the horizontal group, in the vertical group it was found to be 79.00 ± 2.5 ($p < 0.01$).

CONCLUSIONS

Electrodiagnostic study revealed similar results in both groups. According to these results, significant difference in mean ASES scores of both groups was not related to sensorial injury of the supraclavicular nerve.

Key words: clavicular fractures, supraclavicular neuropathy.

INTRODUCTION

For surgical treatment of clavicle fractures, rigid fixation should be obtained with the chosen technique in order to facilitate early mobilization (7, 19, 21, 35). Plate implants have evolved from conventional reconstruction plates – which have been associated with deformation at the fracture site – to contemporary pre-contoured locking plates. The latter have advantageous biomechanical properties and low complication rates in the elderly (5, 13, 16, 18, 30). Following fixation with plate, supraclavicular neuropathy and numbness may occur due to damage to branches of supraclavicular nerve (11, 12, 32, 34).

Branches of supraclavicular nerve, cross the clavicle at almost a right angle (2, 8). This position may make them susceptible to injury with horizontal incisions which are parallel to long axis of clavicle (Fig. 1). To avoid this complication, it was hypothesized that a vertical incision perpendicular to long axis of clavicle could be used and was found to be effective (34).

In comparison to other similar studies in the literature, we tried to compare the clinical results of clavicular fractures operated by superior locking plate using horizontal and vertical incisions by physical examination, electromyography and nerve conduction tests to find out if any significant difference between clinical results of both incisions regarding the supraclavicular neuropathy occurs or not.

MATERIAL AND METHODS

Approval was obtained from the local scientific department of our hospital and consent to study participation from all subjects for that randomised prospective study. Between January 2010 and January 2013, 63 patients with displaced midshaft clavicle fracture were treated with superior locking plate (22 female, 41 male). A horizontal incision; parallel to the long axis of the clavicle and a vertical incision; perpendicular to the long

axis of the clavicle were used. Mean interval between trauma and surgery was 3 days (1 to 8 days).

The operation was performed under general anesthesia with the patient placed in the modified beach-chair position. 38 of 63 clavicle fractures were fixed with superior locking plate using horizontal incision (group 1) and 25 of the fractures were fixed with the same plate using a vertical incision (group 2) (3.5 mm superior locking plate, TST, Turkey). The supraclavicular nerve was not specifically dissected in any of the cases.

For 4 weeks postoperatively, the arm was immobilized in a shoulder abduction brace. However, early passive mobilization was allowed with abduction and forward flexion. After 6 weeks, all patients were examined clinically and radiographically, and rehabilitation was continued with free range of motion and strengthening exercises. Return to sports was allowed 12 weeks after surgery.

Mean age of group 1 was 32 ± 3.7 years (range: 28–36), and mean age of group 2 was 29.8 ± 3.2 (range: 25–34). Mechanism of injury was motor vehicle accident in 29, sports in 18, bicycle accident in 7, fall from high in 5, and others included 4 patients. According to AO/OTA fracture and dislocation classification, thirty-one of the cases were type 15-B3, twenty-three were type 15-B2, and nine were type 15-B1.

At a mean follow up of 12 weeks (range 10–15 weeks) shoulder examinations were carried out by an experienced examiner using the ASES (American Shoulder and Elbow Surgeons) (25) which is a standardized form for assessment of the shoulder and a detailed physical examination was performed for the involved shoulder girdle at standing position. Any significant muscular atrophy, asymmetry or findings that could be possibly associated with suprascapular neuropathy were investigated. All of the patients were asked if they felt any numbness on their shoulder girdle, chest or breast. Abduction and forward flexion were carried out to evaluate the scapulothoracic rhythm. Active and passive external rotation and shoulder abduction were assessed for

Table 1. Comparison of mean ASES scores of two groups

| | ASES |
|---------|------------------|
| | mean \pm SD |
| Grup I | 76.39 \pm 1.20 |
| Grup II | 79.00 \pm 2.5 |
| p | 0.001** |

Student *t*-test

** $p < 0.01$

Table 2. Results of electrodiagnostic study

| | Electrodiagnostic findings | |
|---------|----------------------------|--------------|
| | exist | do not exist |
| | n (%) | n (%) |
| Grup I | 8 (%21.1) | 30 (%78.9) |
| Grup II | 6 (%24.0) | 19 (%76.0) |
| p | 1.000 | |

Continuity (Yates) correction

any weakness of infraspinatus or supraspinatus muscles.

AP radiographs were obtained for radiographic follow up.

Electrodiagnostic tests were performed to 15 patients who felt persistent numbness across their shoulder or chest (8 patients from horizontal group and 7 patients from vertical group) after six months, postoperatively. Low sensory nerve action potentials (SNAP) and prolonged sensory nerve conduction velocities (NCV) over affected segments were detected in 14 of the patients. In one of the patients from the vertical incision group who felt numbness across his shoulder, the electrodiagnostic evaluation was completely normal.

IBM SPSS Statistics 22 (IBM SPSS, Türkiye) programme was used for statistical analysis. Student t-test was used for comparison of normally distributed parameters (quantity) and continuity (Yates) test was used. $p < 0.05$ was accepted to be statistically significant.

RESULTS

There was no significant difference among both groups in terms of height, gender, weight, fracture type, and mechanism of injury. The mean ASES score of the affected shoulder was 76.39 ± 1.20 in horizontal group, and the mean ASES score of the vertical group was 79.00 ± 2.5 ($p < 0.01$). Statistically significant difference was found between the ASES scores of the horizontal group and the vertical group (Table 1).

On physical examination, there was no hypotrophy of infraspinatus or supraspinatus muscles. 8 patients of the horizontal group and 7 patients of the vertical incision group described numbness across their shoulders. These 15 patients did not have any limitation of movement, 14 patients had abnormal electrodiagnostic findings. All of them were sensorial injuries, 8 of the patients were from horizontal group and 6 of the patients were from vertical incision group. We did not find any statistically significant difference between both groups in means of electrodiagnostic findings (Table 2).

DISCUSSION

Clavicle fractures are common injuries in young active individuals. They are frequent and account for 2.6 % of all fractures (24). The majority of fractures occur in the midshaft of the bone due to axial compressive forces applied to the shoulder resulting in fracture (26, 27).

Recent studies have shown a high prevalence of symptomatic malunion and nonunion after nonoperative treatment of displaced midshaft clavicular fractures (1,



Fig. 1. Supraclavicular nerve crossing parallel to long axis of clavicle.

2, 10, 14, 15, 20). Reported nonunion rates following surgical fixation of clavicle fractures were initially higher than those reported following nonoperative treatment (3, 18). More recent studies, however, suggest higher complication and nonunion rates of up to 15% following nonoperative treatment, in particular for patients with displaced midshaft clavicle fractures (DMCF). In addition, these patients are at high risk of residual pain, disappointing cosmesis and shoulder dysfunction (3, 9, 14, 31).

The goal of surgery is to improve the functional outcome, avoid non-union and symptomatic mal-union by achieving close-to-anatomic reduction. In our study, we used superior locking plates for fixation of displaced clavicular fractures. Locked plates are found superior to unlocked plates in various studies (5, 7, 30). Possible complications of plate fixation are implant failure, cosmetic problems, infection, nonunion and numbness across the shoulder and chest (8, 28, 29).

The suprascapular nerve is a mixed motor and sensory nerve arising from the upper trunk of the brachial plexus. It courses posteroinferiorly beneath the superior transverse scapular ligament in the suprascapular notch to supply the supraspinatus muscle. It then passes inferolaterally to innervate the infraspinatus muscle as depicted. Sensory fibers of this nerve supply the acromioclavicular and glenohumeral joint capsules as well as the scapula (4, 22, 23, 33). Injury to the nerve at the suprascapular notch causes weakness of both the supraspinatus and infraspinatus muscles, whereas injury at the spinoglenoid region affects only the infraspinatus muscle (6).

Branches of the supraclavicular nerve may be injured during the operation for clavicle fracture. In an anatomical study, it was found that the terminal branches of the supraclavicular nerve did not course over the clavicle in a predictable pattern and did not quantify

distances of each supraclavicular nerve branch with respect to clinically appreciable clavicular landmarks. This unpredictable localisation of supraclavicular nerve increases its vulnerability during surgery for clavicle fractures (17).

Weakness or muscle loss may also be a prominent presenting complaint in suprascapular motor neuropathy. The weakness is most often in external rotation (infraspinatus muscle) and in initiation of abduction of the upper extremity at the shoulder girdle (supraspinatus muscle). Physical examination of our patients did not reveal motor loss of the muscles innervated by suprascapular nerve. There was no atrophy or hypotrophy of supraspinatus or infraspinatus and movements of the involved shoulder joint was normal. According to the ASES test, significant difference was found between the horizontal incision group and the vertical incision group. This finding could be related to better tolerance to rehabilitation in the vertical incision group. Tension over the horizontal incision site at early postoperative period might be more than tension over vertical incision site due to perpendicularly acting forces on sutures during add-abduction.

Vertical incision technique has been studied and postoperative numbness across the shoulder was found significantly less than horizontal incision technique (35), however in our study, we did not find any significant difference between both groups in case of numbness across shoulder girdle or chest. Electrodiagnostic findings of one patient from vertical group who also felt numbness were found to be normal.

One reason to sensorial abnormalities following surgery for clavicle fractures might be the displaced fractured bone endings interfering with branches of supraclavicular nerve. An additional branch to supraclavicular nerve was found in 49 % in a cadaveric study (17). In the same study ninety-seven percent of the specimens were found to have a medial or lateral branch of the supraclavicular nerve, and authors

commented that there was no safe zone for surgery of clavicle fractures made through transverse incisions. Abnormal electrodiagnostic findings due to sensorial abnormalities that occur following surgery for clavicle fractures seem to be unavoidable due to lack of precise localisation of the medial and lateral branches of the supraclavicular nerve and the additional intermediate branch (17).

Risk of nerve injury should be increased in case of additional branch of the supraclavicular nerve. Limitation to the study is that the group of patients is small, although these fractures are very common injuries. However, surgery of clavicular fractures through vertical incision is relatively rare in clinical practice.

CONCLUSION

As a result of our experience of these two incisions; vertical incision for surgery of clavicle fractures is a technically demanding procedure compared to the horizontal incision. Electrodiagnostic findings revealed that sensorial abnormalities due to damage to branches of supraclavicular nerve did not occur significantly less than the horizontal group. However there was statistically significant difference between both groups in means of ASES scores. Electrodiagnostic findings of both groups were found similar. This finding indicates that the difference between ASES scores is probably not related to nerve injury. Rehabilitation might have been better tolerated by the vertical incision group, which might be further investigated.

Conflict of interest

Each author certifies that he or she or a member of his or her immediate family, has no funding or commercial associations (e.g., consultancies, stock ownership, equity interest, patent licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

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