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TRAUMA SURGERY

Does a skin incision along Langer's lines reduce complications following fixation of displaced middle-third clavicle fractures?

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Abstract

Introduction Internal fixation of displaced middle-third clavicle fractures is a widely used treatment but is frequently associated with post-operative complications. The aim of this study is to investigate whether or not using a skin incision along Langer's lines, as opposed to a traditional transverse incision, reduces complications.

Methods We retrospectively reviewed data on 108 patients who underwent open reduction and internal fixation of mid-shaft clavicle fractures between 2014 and 2018. Either an oblique incision along Langer's lines or a transverse incision was used according to surgeon's preference. A pre-contoured diaphyseal locking plate was used in all cases. We collected data on fracture classification, minor complications (irritation from plate, chest wall numbness, superficial wound infection) and major complications (irritation from plate necessitating metalwork removal, periprosthetic fracture, deep infection, neurovascular injury and non-union). Statistical analysis was performed using multivariant regression analysis and Fisher's exact tests.

Results Fifty-seven patients underwent fixation using the oblique incision and 51 via the transverse incision. Age, gender and fracture pattern in the two groups were comparable. There were 14 minor and 6 major complications in the oblique group. In the transverse group, there were 16 minor and 5 major complications. The major complication rate was 10.5% in the oblique group and 9.8% in the transverse group. The overall major complication rate was 10.2%. No statistically significant difference in the rate of complications between the two groups was identified.

Conclusion Based on our data, an incision following Langer's lines does not reduce the rate of complications following fixation of displaced middle-third clavicle fractures.

Keywords Skin incision · Langer's lines · Complications · Fixation · Clavicle fractures

Introduction

Fractures of the clavicle are common. They represent 2.6% of all fractures. Up to 80% of these injuries will occur in the middle-third of the clavicle [1]. Open reduction, internal fixation (ORIF) is a widely used treatment for displaced middle-third clavicle fractures with benefits including improved early satisfaction scores and a substantially a lower rate of non-union [2, 3]. Complications following surgical fixation of clavicle fractures are common. Figures reported in the literature include a reoperation rate up to 27.4% and the presence of cutaneous hypoesthesia in up to 64% of patients [4, 5]. Other complications following ORIF include skin numbness, metalwork irritation, re-fracture, infection, non-union and vascular injury.

A variety of skin incisions have been described for fixation of clavicle fractures. The transverse skin incision follows the superior border of the clavicle (Fig. 1). The oblique

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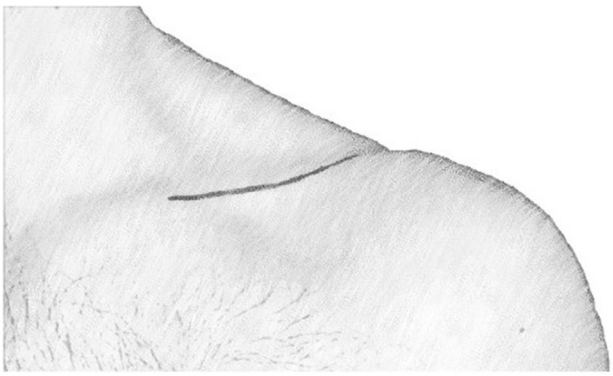

Fig. 1 The transverse skin incision

incision for middle-third clavicle fracture fixation follows Langer's lines (Fig. 2). The vertical incision runs perpendicular to the length of the clavicle. It has been associated with shorter wounds and less likelihood of skin numbness, however, is a more a more popular approach for lateral third fractures where a shorter skin incision is more easily utilised [6, 7].

Langer's lines also known as skin tension lines have long been used as a guide to planning surgical incisions. The lines are subtle creases in the skin which follow the orientation of dermal collagen fibres. There is a general acceptance in the surgical community that an incision following Langer's lines gives cosmetically pleasing surgical results [8]. Evidence suggests that the appearance of such an incision is more pleasing to patients [9]. The theory proposed here is that a skin incision along Langer's lines is under reduced tension, and therefore, less likely to result in complications. With this study, therefore, we aim to determine whether or not the oblique incision is associated with fewer post-operative complications than the transverse incision.

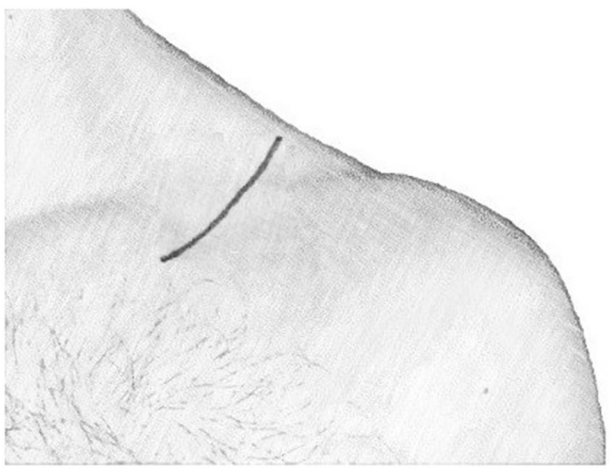

Fig. 2 The oblique skin incision

The work was approved by the appropriate ethical committee related to the institution in which it was performed.

Methods

To test this hypothesis, a retrospective cohort study was performed. Patients undergoing plate fixation via an oblique skin incision were compared with those who had a transverse skin incision.

Cases were taken from a database of all acute referrals to the Trauma and Orthopaedic team at a single-level II Trauma Centre. They were performed between January 2014 and June 2018. All patients had displaced middle-third clavicle fractures. Fractures were treated with open reduction and were fixed with a pre-contoured superior diaphyseal locking plate (Stryker VariAx Clavicle or Smith & Nephew Peri-Loc Superior-Medial locking plate) in all the cases.

All the cases were performed or supervised by a consultant Trauma and Orthopaedic surgeon with the patient in the 'beach-chair' position. The choice of incision (transverse or oblique) was surgeon's preference. Exclusion criteria were: age < 16 years, open fractures, proximal and lateral third fractures, fixation with elastic nail and those patients followed up out of region.

The primary outcome measure was frequency of complications. Complications were divided into minor and major as shown in Table 1. Further surgery for any reason, including removal of metalwork, was considered a major complication. Data were collected on: type of skin incision used (transverse or oblique as recorded in the operative note), gender, age, date of injury, side of injury and fracture classification (AO). Information was collected from operation notes and clinic letters (Tables 2, 3).

Results

The database contained 256 displaced clavicle fractures in the timeframe described. Undisplaced fractures, where surgery was never considered, are not referred to the Trauma and Orthopaedic team, and therefore, not included in the database. Of 256 fractures in the database, 160 underwent

Table 1 Minor and major complications

Minor complications	Major complications
Skin numbness	Non-union
Superficial infection	Deep infection
Metal work irritation	Metalwork irritation requiring plate removal
	Re-fracture
	Re-operation for any other reason
	Vascular injury

Table 2 Patient demographics

Skin incision	Oblique ($n=57$)	Transverse ($n=51$)	p value
Age (mean years)	41.39	37.87	0.23
Gender			
Male	48	43	0.96
Female	9	8	0.99
Laterality			
Right	31	25	0.72
Left	26	26	0.66
AO classification			
15.2A	15	17	0.49
15.2B	7	4	0.48
15.2C	35	30	0.89

Table 3 Summary of complications

	Oblique ($n=57$)	Transverse ($n=51$)
Minor complications		
Numbness	13	12
Irritation (plate left in situ)	1	3
Superficial wound infection	0	1
Total minor complications	14	16
Major complications		
Non-union	1	1
Deep infection	1	1
Irritation (plate removed)	4	1
Re-fracture	0	1
Re-operation any other reason	0	1
Total major complications	6	5
Grand total complications	20	21

surgery. Fifty-two fractures were excluded from the study (age < 16 years, lateral third fractures, fixation with elastic nail, those patients followed up out of region). This meant 108 fractures were eligible for this study. Of those 108, 57 were in the oblique group and 51 in the transverse group (Fig. 3). There were 91 men and 17 women. The mean age of patients was 39.73 years. Gender, age, laterality and fracture classification were comparable between the two groups (*T* test and Chi-squared test). Patients were followed up for 22.5 weeks on average. Data from nine consultants were included.

In the oblique group ($n=57$), there were 14 minor complications and 6 major complications. The minor complications were 13 cases of skin numbness and 1 case of metalwork irritation without removal. There were no superficial wound infections. The six major complications were: one non-union treated with revision ORIF, one deep infection (treated with antibiotics, washout and removal of metalwork) and four cases of metalwork removal owing to irritation caused by the plate. In total, six patients required further surgery.

In the transverse group ($n=51$), there were 16 minor complications and 5 major complications. The minor complications included 12 patients with skin numbness, 3 with irritation caused by prominent metalwork but for whom the metalwork was left in situ and 1 superficial skin infection successfully treated with antibiotics. The five major complications were one case of non-union (treated with revision ORIF), one case of deep infection (treated with antibiotics, washout and removal of metalwork), one case of metalwork irritation necessitating removal, one re-fracture (treated with revision ORIF) and one case where metalwork was removed at the patient's request as a prophylactic measure. This patient was suffered a re-fracture of the opposite side following elastic nailing. In total, five patients returned to theatre in the transverse group.

Statistical analysis was performed using multivariant regression analysis and Fisher's exact tests. Regression analysis demonstrated that none of the variables present in the study population (age, gender, laterality, AO Classification and operating surgeon) were predictive of complications. Fisher's exact tests were applied to each complication in turn. Skin numbness was reported by 13 patients (22.8%) in the oblique group and 12 patients (23.5%) in the transverse group. There was no significant relationship between incision type and numbness ($p=0.929$). Patients were no more likely to experience metalwork irritation in the oblique group compared to the transverse group ($p=0.862$). There was one case in the oblique group and three cases in the transverse group where the plate caused irritation; however, the decision was made not to remove it. This association was not statistically significant ($p=0.257$). More patients in the oblique group underwent removal of metal for irritation than in the transverse group (4 patients and 1 patient, respectively); however, again this relationship was not statistically significant ($p=0.212$). Six patients required re-operation in the oblique group compared with five in the transverse group signifying no difference between the two ($p=0.901$).

Discussion

Cutaneous hypoesthesia is a common occurrence following plate fixation of the clavicle with up to 64% of patients affected [5]. This is thought to be caused by damage to branches of the supraclavicular nerve. In the majority of patients, this numbness improves over time with very few reporting long-term severe numbness [10]. In this study, 25 of 107 patients (23.4%) were affected by numbness. These patients were evenly spread between the two groups

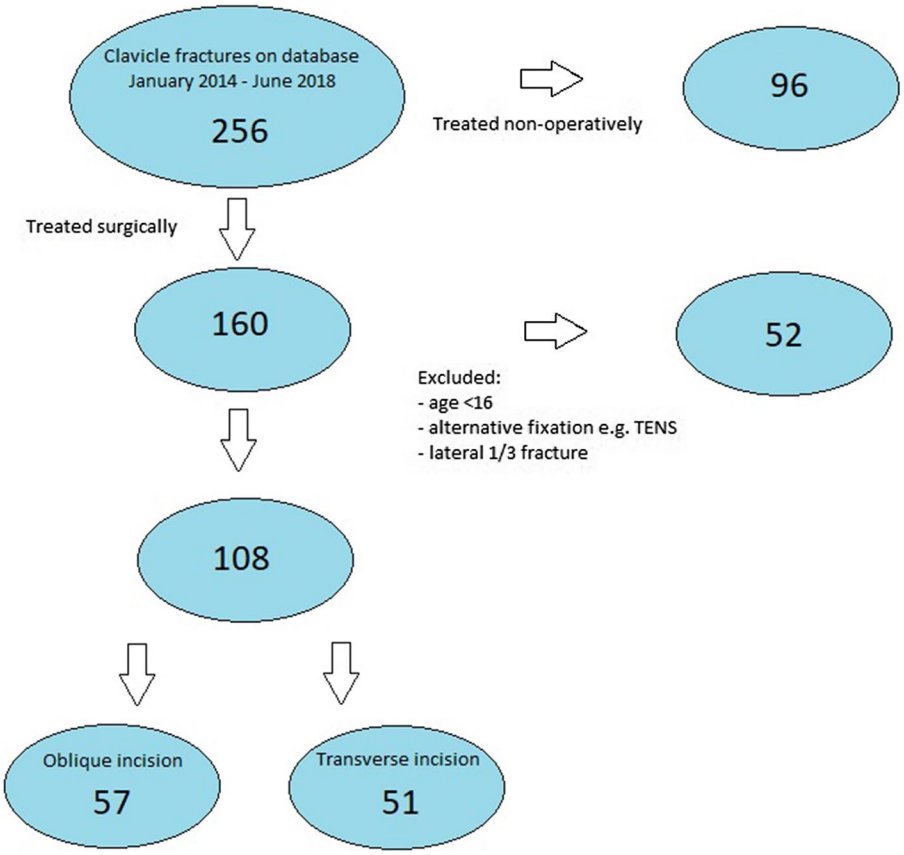

Fig. 3 Patient selection

with 13 in the oblique incision group and 12 in the transverse group. There was no statistically significant association between incision type and skin numbness. This suggests that the type of incision (oblique or transverse) does not impact the likelihood of injuring branches of the supraclavicular nerve and subsequent cutaneous hypoesthesia.

Irritation caused by a prominent plate is another frequent complaint following clavicle fixation. Four plates were removed for irritation in the oblique group versus just one plate in the transverse group. This difference was not statistically significant. The decision whether or not to remove metalwork is surgeon dependent meaning that the difference between the two groups may be explained by the difference in practice between operating surgeons.

Infection is a potentially serious complication of clavicle fracture fixation. Deep infection will likely necessitate further surgery and occurs in approximately 4.5% of cases [4]. In this study, there was one superficial infection (in the transverse incision group) and two deep infections (one in each of the two groups). We had reasoned that an incision along Langer's lines would be under less tension and so less likely to run into complications. It follows that wound dehiscence and subsequent infection would be less likely. This is not borne out in our results, however. No statistically significant association between incision and infection was demonstrated.

Non-union occurred in two cases, one case in each group. Again, there was no associated between incision type and non-union although the numbers were small.

The benefit of this study is its comparatively large sample size. Chechik et al. and Shukla et al. both compared skin incision for clavicle fixation with 38 and 36 patients, respectively [6, 9]. Our findings mirror both studies with no difference in complications between the two groups. A mean follow-up of 22.5 weeks is sufficient for most complications of clavicle fracture fixation to have declared themselves.

This study shares the limitations of any retrospective cohort study: a reliance on the quality of data collected by others without this study in mind (for example documenting skin numbness), the possibility of selection bias through the absence of randomisation and missing data. A patient satisfaction score would have added valuable insight to the study but would have posed logistical problems given that this is a retrospective study. This remains an area for future investigation. The final limitation concerns follow-up. With one exception, each surgeon in the study performed either an oblique or a transverse skin incision for all their cases. As such patients in the two groups received post-operative care

(duration of follow-up, frequency of radiographs, likelihood of metalwork removal) associated with their given surgeon which was not guaranteed to be identical between the two groups. Mean follow-up is short (22.5 weeks), however, this period of time will capture the majority of complications discussed here.

Conclusion

In conclusion, we have not found any evidence to support the theory that a skin incision along Langer's lines reduces tension across the wound, and therefore, reduces post-operative complications. The choice of surgical incision for middle-third clavicle fracture fixation (oblique or transverse) should not be based on the likelihood of incurring complications as the present study has shown that no difference between the two exists.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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