



## THE EVALUATION OF RESULT OF MINIMALLY INVASIVE TREATMENT IN THE FRACTURE OF CLAVICLE WITH CANNULATED CANCELLOUS SCREW - IN VIVO STUDY

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### ABSTRACT

**Objective** - To evaluate the effect of minimally invasive Treatment in the fracture of clavicle with cannulated cancellous screw.

**Method** -Data of 10 patients who were operated with minimally invasive treatment with cannulated cancellous screw for the clavicle fracture from January 2017 to May 2018 were prospectively analysed & compared with those of 10 patients with clavicular fracture who had been operated with plate. According to Craig's classification there were 3 of group I and 7 of group 2-II. Neer Scores were used to evaluate shoulder function and radiographs to assess fracture union.

**Result** - In the cannulated cancellous screw fixation of clavicle, the incision length was 4-5cm where as in the reconstructive plate fixation of the clavicle it was 10-11cm. Although bone union was achieved in both groups but the bone union time being 13.2±6.9weeks in cancellous cannulated screw fixation and 16.3±8.7 weeks in the reconstructive plate fixation. All the patients were followed up for 6 to 20 months (average 10.6months). The average neer score was 96.6±3.4 in CGS group and Screw loosening occurred in one patient treated with cannulated screw fixation. There was a significant difference in fracture healing time between two groups but not much significant difference in Neer Score.

**Conclusion** - The treatment of clavicle fracture with cannulated screw has the advantage of minimal invasion, short duration of bone healing, good clinical outcomes and being relatively inexpensive.

**KEYWORDS :** Bone, Bone Screw, Clavicle, Fractures, Intramedullary.

### Introduction

Recently, the two main procedure for surgical treatment of clavicular fractures are internal fixation with a plate or with Kirschner wire. Plates provide reliable and secure fixation, but require a long incision and have to be removed in a second operation; The possible complications include implant failure and wires were once widely applied because the procedure is simple and costs little. However, because it provide poor stability and has multiple complications, Kirschner wires are gradually being abandoned<sup>1</sup>. Wang *et al.* used closed reduction with elastic threaded screws to treat clavicular fractures and achieved good results<sup>2</sup>. However, this procedure requires X-ray imaging guidance and has the risks of puncturing the apex of the lungs, vessels and nerves. Meanwhile, the threaded screws are too thin (1.5-2.5mm in diameter) to achieve firm fixation and have the complications of screw failure, subcutaneous bursitis, and pressure ulcer.

In light of the above considerations, we assessed minimally invasive intramedullary fixation with cannulated screws to treat clavicular fractures. The study prospectively analysed data of patients with clavicular fractures treated by minimally invasive intramedullary fixation with cannulated screws and compared them with patients who had undergone internal fixation with reconstructive plates. Its objective were: (i) To evaluate the effectiveness of minimally invasive intramedullary fixation with a cannulated screw, which is an easy, inexpensive, and reliable technique for achieving intramedullary fixation of clavicular fractures; and (ii) To compare its effectiveness with that of reconstructive plate fixation.

### Materials and methods

#### Patient characteristics and fracture assessment procedure

10 patients with clavicular fractures treated by retrograde transfixation with 6.5mm diameter cannulated screws from January 2017 to May 2018 were studied. They comprised 10 males aged 20 to 60 yrs. with mean of 40 yrs. The cause of all fractures were road traffic accident. According to Craig's typing<sup>3</sup> 3 cases (30%) were type I and 7 (70%) type II.

Another 10 case of clavicular fracture treated by reconstructive plate by the same doctor from January 2017 to May 2018. This group comprised 10 males aged (18-57yrs). With a mean of 37.5 yrs. All the cases of clavicle fracture were due to road traffic accident. According to Craig typing 3 cases (30%) were type I, 5 cases (50%) type II and 2 cases (20%) type 2-V

### Surgical procedures

#### Minimally invasive intramedullary fixation with cannulated screw:-

After brachial plexus anaesthesia the patient was placed in a supine position and the shoulder blade on the affected side elevated by placing a pad beneath it to form a 30 degree angle with the bed. Standard disinfection was performed, sterile towel draped and the operative area covered with iodine operation film.

Taking a point 1cm from the fracture end toward the lateral side as the centre, a transverse incision 4-5 cm long was made along the anterior edge of the clavicle. The proportion of exposure of distal and proximal fracture ends was 2:3.

The distal end of the fracture was lifted with globular-shaped bone-holding forceps and the guide pin inserted as far as possible (0.5-1cm) into the medullary cavity of the distal fractured end, adjusting the angle to ensure it was located in the centre line of the medullary cavity and in alignment with the axle wire of the acromial protuberance posteriorly, the objective being to keep the greatest length of the guide pin possible in the medullary cavity of the distal fractured end and to ensure it emerged at the central point of the acromion. Generally a 2.3 mm-diameter threaded guide pin was inserted along the centre line of the clavicular cavity from the distal end of the fracture toward the lateral side and through the clavicular cortex to the subcutaneous tissue adjacent to the S-shaped protuberance posterior to the acromion at the distal end of the clavicle. A 1cm-long skin incision was made to allow the guide pin to protrude (fig. 1A). Using a 5 mm diameter cannulated drill, the medullary cavity was enlarged from the acromion outlet by drilling retrogradely and a 6.5 mm diameter cannulated screw tapped in along the guide pin. The proximal end of the fracture was prepared in the same way, ensuring that the guide pin did not go through the anterior cortex of the clavicle at its proximal end. Drilling with the cannulated drill was stopped when resistance was felt from the bone cortex. Reduction forceps were used to clamp and reset both fractured ends in an orthophoric position, the guide pin brought back through the fractured ends and its length measured. Next, a 85-100 mm long, 6.5 mm-diameter cannulated screw was screwed in along the guide pin through the posterior skin incision (fig. 1B). In most cases, a 100 mm-long cannulated screw fit. The main aim was to keep the whole length of the thread on the tip of the cannulated screw in the inner cortex of the cavity of the proximal fractured end. When the cannulated screw had been screwed in, both ends of the fracture were secured in a satisfactory position with reduction forceps and rotation resisted.

Meanwhile, the bone fragments were aligned, keeping pressure on them to secure them (fig. 3C). The head of the cannulated screw was inset into the bone cortex of the acromion as far as possible to reduce the subcutaneous space occupied and enhance stability. The affected-side forearm was supported with a sling postoperatively.

#### CLINICAL VIEW

#### RADIOLOGICAL VIEW

Fig A

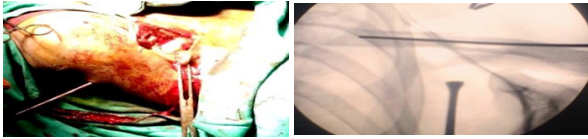


Fig B



Fig C

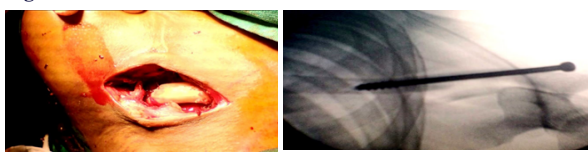


FIG 1- Schematic diagram of intramedullary fixation of a clavicular fracture with a cannulated screw.

- The guiding device has been pushed into the medullary cavity of the distal fractured end, Then the guide pin inserted and pushed out posterior to the acromion.
- The fractured bone has been set, then the guide pin pushed back into medullary cavity of the proximal fractured end and the cannulated screw screwed in along the guide pin after tapping.
- The clavicular fracture is fixed.

#### Clavicle reconstructive by plate fixation

The standard procedure of clavicle reconstructive plate fixation was performed and the affected-side forearms supported with a sling postoperatively.

#### Postoperative management

Both group of patients received standard antibiotics for 3-5 days. Graduated exercises for the shoulder joint with pendular movements in a range of 15°-20° with the protection of a forearm sling were commenced from the postoperative second day. The sling was removed when X-ray films showed growth of callus or an indistinct fracture line.

#### Follow-up and Observation index

The patients were followed up in the outpatient department in the first, third, sixth and twelfth postoperative weeks, after which regular examination were performed at 4-6 week intervals according to the degree of healing of the fracture. Orthophoric X-ray films of the clavicle were taken to assess fracture union. The criteria for fracture union were standard: (i) no local tenderness; (ii) no abnormal activity; and (iii) clavicle orthophoric X-ray films showing continuity across the bone cortex. Shoulder function was assessed according to Neer criteria<sup>5</sup> after fracture union had been achieved.

Observation indexes included operation, blood loss during surgery, time to fracture union, neer shoulder function score and complications (including infection, nonunion, delayed union, cannulated screw rupture or displacement and plate loosening or rupture).

#### Evaluation of Effectiveness

The Neer's shoulder function score was used to evaluate the effect of treatment; this includes pain, function, motion range and anatomical restoration, 100 points being a perfect score<sup>4</sup>.

#### Statistical analysis

Statistical analysis was carried out with the SPSS 13.0 package. The duration of surgery, blood loss during surgery, time to fracture union

and Neer shoulder function score were compared between the cannulated screw group (CSG) and clavicle reconstructive plate group (RPG) with student's two independent sample t-test. The  $\alpha$  value for significance was set at 0.05 in the two sided tests.

#### Result

##### patient characteristics

There were no significant differences in age ( $t=1.71, P=0.19$ ), and Craig typing ( $\chi^2=24.87, P=0.82$ ) between the two groups.

##### Operative variables

All 10 cannulated screw fixation procedures ran smoothly with no clavicle cleavage and an operation duration ranging from 20 to 45 min, with a mean of 32.0 min. Intraoperative blood loss ranged from 5 to 40 ml, with a mean of 22.0ml. The length of the incision range from 3 to 4 cm. All 10 clavicular reconstruction with plate fixation procedures also all ran smoothly with an operation duration ranging from 35 to 70 min, with a mean of 52.0min. Intraoperative blood loss ranged from 20 to 70 ml, with an average of 46.0ml. The length of the incision ranged from 10 to 11 cm. There were statistically significant differences between the two groups in operation duration and blood loss ( $P<0.05$ , Table 1).

##### Clinical assessment

All patients in both group were followed up for from 6 to 20 months, with a mean of 10.6 months. Bony union was achieved in all cases. Time to fracture union in the CSG ranged from 7 to 20 weeks, with a mean of  $13.2 \pm 6.9$  weeks whereas in the RPG it ranged from 7 to 25 weeks, with a mean of  $16.3 \pm 8.7$  weeks; this difference was statistically significant ( $p=0.018$ , table 1). During the most recent follow-up, shoulder activity was assessed according to Neer's system. The CSG gained from 87 to 100 points, the mean being  $96.6 \pm 3.4$  points, whereas the RPG gained from 83 to 100 points, the mean being  $94.2 \pm 5.8$  points; this difference is not statistically significant ( $p=0.062$ , table 1).

##### Complications

No postoperative infection, local skin necrosis, or non-union occurred in the CSG. Within 3 weeks of surgery, one of the patient had slight screw withdrawal towards the distal end, the screw having rotated and cocked a little against the skin: none of these patients required further treatment. One of the patient with splintered fracture were noted to have slight rotating change in the fracture area during examination in the third to sixth postoperative weeks. These were caused by over activity of the affected side limb and the fractures healed uneventfully with 3-4 weeks clavicle strap protection and reduced activity.

Two patient in the RPG had poor skin healing; however, their incisions healed with regular removal of stitches and dressing changes.

#### Discussion

##### The feasibility of minimally invasive treatment with cannulated screw for clavicular fractures

Because the entire clavicle is about 15cm long and its central straight section is about 12 cm long<sup>5</sup>, it is long enough for intramedullary fixation. In addition, the average vertical height of the clavicle is 1.1 cm in men and 0.9 cm in women and its average anteroposterior diameter is 1.2 cm in men and 1.1 cm in women. The thickness of the acromion, from which the screw protrudes and is later removed, is about 0.9-1 cm, whereas the diameter at the hilt of a 6.5 mm diameter, cannulated screw is 4.5 mm, these dimensions provide the anatomical basis for choosing a 6.5 mm diameter, 85-100 mm long cannulated screw<sup>3</sup>. Removal of these implants can be carried out in clinics under local anesthesia and there is no need for admission to hospital. Also, cannulated screw cost only 1/4-1/3 of the cost of reconstructive plates from the same company, therefore the cost of the former treatment is significantly less. Finally, removal of screws does not injure the clavicle, therefore there is no stress concentration point after they have been removed; thus, the risk of re-fracture is basically eliminated.

Plate used to secure Clavicular fracture may rupture because of mental fatigue<sup>6</sup>, and drilling during the procedure has an associated risk of injuring nerves, vessels, and the apex of the lung beneath the clavicle; the complication rate is reportedly 20.2%<sup>7</sup>. Osteoporosis or short plate ending at the point between the distal and middle 1/3 where the mechanical structure of the clavicle is weakest may cause screw loosening and stress fracture in the junctional zone<sup>8</sup>. Although there is virtually no medullary cavity in distal and middle section of the clavicle, it is still a type of tubular bone and the advantages of intramedullary fixation in tubular bone fracture is universally accepted

. experiments have shown that securing the clavicle with 3.5-4.5 mm diameter cannulated screws achieve three point bending strength and bending rigidity similar to that of a normal clavicle<sup>10</sup>. increasing the diameter of the intramedullary screw by more than 2mm remarkably increases the structural stability and rigidity<sup>11</sup>. using 6.5 mm diameter cannulated screw avoids the risk of screw bending or breaking and confers strong anti angle forming, anti rupture qualities. In addition, inserting of screw avoid the risk to surrounding vessels, nerves, and lung injury associated with plate drilling.

**Comparison between cannulated screw and conventional plate fixation**

The cannulated screw procedure took a much shorter time and caused much less blood loss than the reconstructive plate procedure, the time saving being nearly 50% there was no subsequent significant difference between the two group in Neer shoulder activity scores. We did not compare the lengths of the incisions in these two operations; however, the average length in the CSG was 4-5 cm, just covering the length of the fracture surface is enough. In comparison, in the RPG the incision needed to be 3cm longer towards both the distal and proximal ends to ensure that 2-3 screw could be fixed at each end (the pitch of holes in a reconstructive plate is about 1cm). therefore, we contend that, for the same outcome, the surgical injury in the CSG is less than that in the RPG.

Group	cases	operation duration(min)	blood loss(ml)	time to fracture union(weeks)	Neer score
Cannulated Screw group	10	32.0±12.5	22.0±17.5	13.2±6.9	96.6±3.4
Plate group	10	52.0±17.5	46.0±21.6	16.3±8.7	94.2±5.8
t value	--	2.347	2.804	2.476	1.890
pvalue	--	0.021	0.006	0.018	0.062

The time to fracture union in the CSG was 13.2 ±6.9 weeks and in the RPG 16.3±8.7 weeks. Although this difference is statistically significant, we question whether it is clinically significant. First, doctors performing the cannulated screw procedure became increasingly more skill full, with improved ability to protect the surrounding soft tissues. Theoretically, this may have affected the time to fracture union. The second factor is the accuracy with which we identified craig 2-II fractures. Craig 2-II fractures are on the medial side of the coracoclavicular ligament, with conoid ligament laceration and uninjured trapezoid ligaments, when the trapezoid ligament is also torn, along with horizontal avulsion of the coracoclavicular ligament, the fracture is classified as craig 2-V. because the surgical incision in the CSG was as short as 4-5 cm and the surrounding soft tissue was stripped as little as possible, there may have been a blind area in regard to assessing injury of the coracoclavicular ligament. This would have resulted in inaccurate fracture typing, which would certainly affect the time to fracture union. Thirdly, there is the factor of timing of follow-up. Follow up occurred in the first, third, sixth, and twelfth weeks, after which it occurred at 4-6 weeks intervals. Thus, apparent time to union was determined by time of follow-up. In addition, the accuracy of time to union time can be influenced by those who interpret the X-ray films. In addition, to the statistical findings, we have also observed clinically that patients treated with cannulated screws recover faster.

**FIG A**



**FIG B**

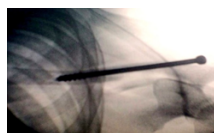


FIG-2 Man, 35 Years old let side clavicle craig 2-II fracture.

(A) Preoperative orthophoric X-ray Film showed splintered fracture medial to coracoclavicular ligament (Craig 2-II)

(B) Postoperatively an X-ray film shows good alignment of the clavicle after reduction.

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