Original Article

Nail Fixation versus Clavicle Support for Displaced Midshaft Clavicle Fractures: Time to Return to Work and Long Term Results

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Background: In the past, conservative treatment was extensively used for both displaced and nondisplaced midshaft clavicle fractures. Many recent reports have indicated that nail fixation results in superior outcomes.

Objective: To compare the time to return to work and long term results, including and incidence of nonunion, between nail fixation and clavicle support for displaced midshaft clavicle fractures.

Materials and Methods: In this descriptive retrospective study,68 patients with displaced midshaft clavicle fractures were randomly and evenly assigned either to receive treatment with nail fixation [NF] or only with clavicle support [CS] provided in the emergency room. Patients in both groups were followed-up for a minimum of 2 years: mean 5.26 (1.66) and 3.34 (0.99) years, respectively. Date of return to work was recorded as were Disabilities of the Arm, Shoulder and Hand [DASH] and Constant-Murley score [CMS] results. Demographic data were analyzed using Chi-square and continuous data were analyzed using the Independent t-test.

Results: Time to return to work was within 6.5 weeks for the NF group and 7.0 weeks for the CS group ($p = 0.104$). After 2 years, DASH and CMS results of the two groups were not significantly different: ($p = 0.740$) and ($p = 0.442$), respectively. However, the initial distance of fragments in the NF group was larger than in the CS group ($p = 0.078$). Nonunion was found in 20% of the CS group, all of whom required further surgery, but none were found in the NF group.

Conclusion: Patients treated with NF and CS return to work after approximately the same period of time. There are no significant differences in DASH or CMS scores with the different treatments. Nonunion is more likely to occur with CS treatment.

Keywords: Displaced midshaft clavicle fracture, Nail fixation, Clavicle support, DASH, CMS constant-murley score?

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The incidence of collarbone fracture was 9% in upper extremities and 4% in all fractures. Most clavicle fractures are caused by impact injuries such as traffic accidents, especially in young patients. Allman classified clavicle fractures into 3 groups based on the site of the fracture. The characteristics of fractures are influenced by the shape of collar bone and muscle attachments. Group 1 fractures are in the middle part of the clavicle and account for 80% of clavicle fractures. Group 2 fractures (17%) are on the lateral side, and group 3 fractures (2%) are at the medial side of the clavicle. Previous studies have reported that non displaced midshaft clavicle fractures treated with an arm sling or with a figure eight bandage required several weeks for pain to subside. The results with an arm sing or figure eight bandage were 95% union and 5% mild malunion. Displaced mid shaft clavicle fractures achieved union with conservative treatment in 97% of cased in an average of 9 weeks; the average DASH score was 24. A recent study found nonunion in more than 15% of cases. De Giorgi et al[1] defined a shortening of the collarbone by 9.7% to be a failure with conservative treatment. Another study stated that

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shortening by more than 2 cm was an indication for surgery. Another study noted that open reduction and reduced malunion by 36% to 4% and nonunion by 29% to 0%. A study by Robinson et al[3] stated that internal fixation could reduce the incidence of nonunion by 1 to 7% and provide improved shoulder function in the first year. Another meta analysis reported that internal fixation reduced malunion, nonunion, and complications more than conservative treatment and also reduced recovery time[4], allowing patients to return to work sooner.

Presently, internal fixation with plate and intramedullary nail is used extensively. Plate fixation requires more surgery time, but provides better shoulder function in the first 6 months than nail only[5]. Although nail fixation was an alternative treatment but minimal soft tissue injury, not only DASH and Constant score were 2.5, 93 respectively but also no malunion in post operative surgery[6]. Similarly, it has been reported that the average bone shortening in comminuted and non comminuted fractures is 10 and 5 mm, respectively, but with the same functional shoulder score[7]. In addition, both plate and nail fixation and conservative treatment were reported to result in equal functional shoulder scores, pain levels, satisfaction scores, and time to union[8]. The present study compared internal nail fixation [NF] with clavicle support [CS], a method previously used extensively in treatment of displaced mid shaft clavicle fractures.

The objectives of the present study were to compare the time to return to work, DASH and CMS results, and incidence of nonunion over the long term with nail fixation and with clavicle support only.

Materials and Methods

This retrospective study was conducted at Pakchongnana Hospital with approval from the Ethics Committee of the Nakhon Ratchasima Provincial Public Health Office (Identifier number KHE 2017-023). Inclusion criteria were patients who were Allman group 1 with a total displacement in the caudad-cephalad plane and no bony contact area, simple fractures (OTA type 15B1 or 15B2), and working age. Exclusion criteria were open fracture, comminuted fracture (OTA type 15B3), neurovascular injury, floating shoulder, and tumor. A total of 82 patients were reviewed for inclusion. Of that number, 6 were excluded and 8 were lost to follow-up. The 68 remaining patients were evenly and randomly assigned by date of treatment to either the nail fixation group (34 cases) or the clavicle support group (34 cases).

The process of nail fixation began with the insertion of titanium elastic nail from the medial part of clavicle. A minimal incision was made above the fracture site and the nails were passed through the site until the distal part of the clavicle was located. The incision had to be performed carefully due to the proximity of a branch of the supraclavicular nerve. After the operation, the initial rehabilitation treatment protocol for both groups specified by a physical therapist was cold compression, pendulum, grip strength, and isometric exercises followed by rotator cuff, range of motion, and strengthening exercises.

Initial shoulder x-ray imaging was done in the upright position and was repeated periodically after treatment. After 3 months of treatment and rehabilitation therapy, suspected cases of nonunion were x-rayed and images were reviewed by a radiologist to confirm the diagnosis. Both the NF and CS groups were followed-up for a minimum of 2 years.

Data on the 68 participants who had a displaced midshaft clavicle fracture treated at Pakchongnana Hospital between October 2010 and September 2015 was obtained from their medical records. Information included demographic and medical data (gender, age, side of injury, AO/OTA classification, distance between fragments). The patients also completed questionnaires (DASH, CMS) and provided data on the date of return to work). In addition, any complications such as nonunion and nail migration were recorded. Demographic data were analyzed using Chi-square and the continuous data were analyzed using the independent t-test. A p-value <0.05 was considered statistically significant.

Results

There were no statistically significant differences in demographic or medical characteristics (gender, age, side of fracture, AO/OTA classification, or distance of fragments) between the two groups. The mean follow-up time was 5.26 (SD 1.66) years in the NF group and 3.34 (SD 0.99) years in the CS group (Table 1).

There were no statistically significant differences between the NF and CS groups in the incidence of non union related to either demographic or medical characteristics.

The time to return to work of the NF and CS groups were 6.5 and 7.0 weeks, respectively ($p = 0.104$). DASH and CMS scores of the groups were 6.5, 6.9 ($p = 0.740$) and 89.7, 88.3 ($p = 0.442$), respectively (Table 3). There were 7 cases of nonunion (20%) in the CS group

Table 1. Demographic and medical characteristics of participants

Data	Nail fixation group (n = 34)	Clavicle support group (n = 34)	*p*-value
Gender, n (%)			0.454
Female	15 (44.12)	11 (32.35)	
Male	19 (55.88)	23 (67.65)	
Age in years (mean ± SD)	34.44 (13.27)	33.21 (10.20)	0.695
Side of fracture, n (%)			0.050
Left	15 (44.12)	24 (70.58)	
Right	19 (55.88)	10 (29.42)	
AO/OTA classification, n (%)			1.000
15-B1	22 (64.70)	23 (67.65)	
15-B2	12 (35.30)	11 (32.35)	
Distance of fragments (cm) (mean ± SD)	0.57 (0.38)	0.42 (0.29)	0.078

Chi-square: gender, side of fracture, AO/OTA classification
Independent t- test: age, distance of fragments

Table 2. Incidence of nonunion of displaced mid shaft clavicle fractures by type of treatment

Indicator	Type of treatment		*p*-value
	Nail fixation (34 cases)	Clavicle support (34 cases)	
Elderly			1.000
>70 years	1	0	
<70	33	34	
DM			0.239
HbA1c >7%	3	1	
No DM	31	33	
Severe anemia			1.000
Hb <7 gm/dl	0	1	
No severe anemia	34	33	
Total lymphocyte count			1.000
<1,500 cells/dl	0	1	
>1,500 cells/dl	34	33	

DM = ; HbA1c = Hemoglobin A1c
Fisher's exact test

which needed further treatment with nailing, but no cases in the NF group. Two of the cases of non union had lateral nail migration. Neither group experienced any serious complications or infection.

Discussion

The incidence of upper limb fractures in 2009 in the United States was 67.6 per 10,000 persons, while the incidence of fractures of the collarbone was 5.8 per 10,000 persons[9]. Patients with injuries to the upper limb recovered sooner than those with lower limb injuries. Return to work was possible after 3 months in 76% of the upper limb group and 58% of the lower limb group[10]. The present study was intended to determine if patients who underwent nail fixation treatment returned to work earlier than those who received clavicle support treatment for displaced mid shaft clavicle fractures.

Table 3. Time to return to work, DASH, and CMS scores by type of treatment

Indicator	Type of treatment		*p*-value
	Nail fixation (34 cases)	Clavicle support (34 cases)	
Time to return to work (weeks), mean (SD)	6.5 (1.2)	7.0 (1.3)	0.104
DASH score, mean (SD)	6.5 (5.3)	6.9 (6.9)	0.740
CMS score	89.7 (7.0)	88.3 (7.9)	0.442

Independent t-test

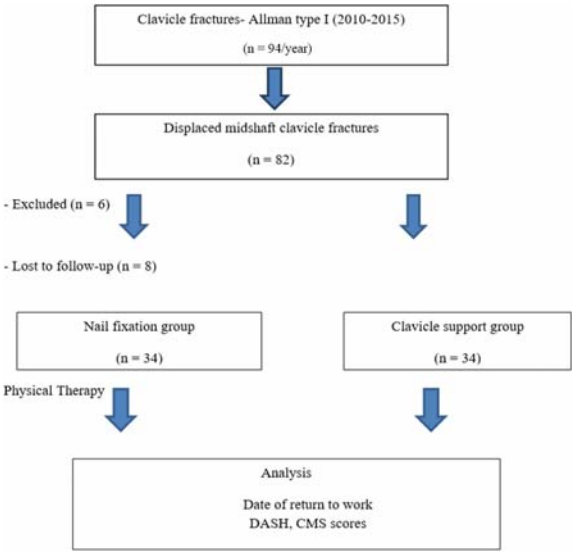

Figure 1. Flow diagram of the study.

Previously, conservative treatment was the most commonly used remedy in both displaced and nondisplaced fractures of the midshaft of the clavicle. One study compared visual analogue scale [VAS] pain scores between patients receiving a figure eight bandage and those receiving an arm sling. The author of that study preferred the arm sling because of its easy application and better level of pain relief[11]. Contrariwise, a meta-analysis concluded that there was insufficient evidence to determine the best conservative treatment for mid shaft clavicle fractures in adults[12]. The present study found clavicle support to be the preferred conservative treatment because it provides increased stability and is easier to use in daily life.

Most treatment of displaced mid clavicle fractures in children was conservative, but there has been controversy regarding the best method for adults. Woltz et al[13] reported the same DASH and CMS scores with surgery and with conservative treatment except nonunion rate. A study by Robinson et al[3] stated that internal fixation improved shoulder function early in the first year, but van der Ven Denise JC et al[14] noted there was no difference after 2 and 5 years. Other meta analysis studies have found better DASH scores in long term with internal fixation[15]. In Sweden, displaced midshaft fractures of the clavicle represented 43% of all clavicle fractures and that they were commonly treated with an operation with plating[16]. Comparing the costs in terms of workdays lost between the surgery and non-surgery groups, the present study found that patients were able to return to work after 8.4 days and 35.2 days, respectively. Other differences in sequelae occurred in the surgery (NF) and the non-surgery (CS) groups, e.g., chronic pain 6.1% and 25.3%, weakness 10.6% and 33.7%, and limited range of motion 15.2% and 31.3%, respectively. The non surgery group in some cases required costly physical therapy, and when nonunion occurred, surgery was required. The authors conclude that the overall cost in the surgery group including lost work days was lower than in the non-surgery group[17]. Primarily for the reasons indicated, internal fixation was considered superior to conservative treatment.

Among alternative surgical techniques?], internal fixation with plating is the treatment of choice for displaced midshaft fractures of the clavicle; however, that surgery needs to be performed carefully because the subclavian artery is only 17 mm beneath the collarbone and the subclavian vein is only 12.4 mm. away. The tips of the screws impinged on vascular structures in 3 out of 15 cases in fresh cadavers after plate fixation at the superior or anterior side. Nail fixation was used in the present study instead plating because it requires minimal dissection of tissue, helping to

maintain the blood supply around the injury site. In addition, nails resist the bending force that occurs with the callus healing process. According other authors, early 6 months after plating was more DASH, constant score than nail fixation. After 6 months, there was no significant difference between the two methods[5], in addition VAS scores were satisfactory, and there was no difference in duration of union between the groups[8]. A recent study reported that neither type of fixation had any serious complications, but plating resulted in more irritation and loosening of the implant than did nails after 1 year, but the difference was not statistically significant[19].

Nail fixation is an alternative surgical treatment that involves inserting an implant through the intra-medullar canal. The implant is easily removed without general anesthesia. There are many types of nails such as elastic nail, Knowles pins, Rockwood pins, and hybrid devices. The present study chose elastic nails because of the ease of insertion into the curved bone of the clavicle. Also, sequelae such as migration, which depended on technique and severity of the fracture site, were minimal. Generally, inserting the nails was not difficult. Most nails were inserted from the medial side of clavicle, which is safe, has minimal complications, and results in improved VAS, DASH and CMS scores as described in the Materials and Methods section[6]. Another study by Rapp et al[20] also preferred nail fixation in young adults (more than 10 years old), reporting that patients were able to regain motion rapidly and to return to sports early. Comparison of the use of nails in simple (OTA type 15B1 and 15B2) and comminuted fractures (OTA type 15B3) of the mid shaft clavicle was studied by Langenhan et al[7]. Those authors found no differences in either DASH or CMS scores or in the amount of shortening. Similarly, a study by Smekal et al[21] which compared nail fixation and conservative treatment found improved DASH and CMS scores in the first 2 years and rapid return to activities of daily living [ADL]. Smekal reported a few cases of nonunion and mal union, but only in the conservative treatment group. The present study continued follow-up to 5.26 years for the nail fixation group and 3.34 years for the clavicle support group. The time to return to work in the nail fixation group and the clavicle support group were 6.5 and 7.0 weeks, respectively ($p = 0.104$), with no statistical significance. Although the results were superior in the nail fixation group for both DASH ($p = 0.768$) and CMS ($p = 0.451$), the differences were not statistically significant. It was noteworthy that the initial distance of fragments in the NF group was greater than in the CS group ($p = 0.078$). The results could have been worse than reported in this article if clavicle support were applied in patients with greater initial distance of fragments. In addition, the present study found 20% non union cases which required further surgery, all in the CS group. The incidence of nonunion in the CS group was approximately the same as reported in previous studies.

Some limitations of the present study should be noted. The date of return to work of participants in this article was obtained from individual questionnaires rather than the official certificates of return to work used in the United States. Patients with various kinds of occupations such as craftsman, officer, laborer, and farmer did not complicate the assessment of DASH and constant score however, they may not be the same as the date of return to work. The sample size was not large, although it included all patients treated within a 5 year period at Pakchongnana Hospital, but it was sufficiently larger for statistical analysis.

Conclusion

Nail fixation group return to work sooner than clavicle support patients, but the difference is not statistically significant. There is no significant differences in DASH or CMS scores between the two treatments in the long term. Nonunion occurs in about 20% of clavicle support patients, but few or none occur in nail fixation patients.

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What is already known on this topic?

Previous studies, displaced mid shaft clavicle fracture treated with arm sling or figure of eight bandage several weeks to relieved pain. Nowadays, the authors found non union more than15% in this group. Another study also noted that open reduction and internal fixation reduced mal union by 36% to 4% and non union by 29% to 0%. The other study by Robinson et al stated internal fixation could reduce non union by 7% to1% with improved shoulder function in the first year.

Nowadays, internal fixation with plate and intra medullar nail are extensively used. Although nail fixation was an alternative treatment but minimal soft tissue injury. Beside that, plate and nail fixation created equally functional shoulder score, pain level,

satisfaction score and time of union.

What this study adds?

There were many types of nail fixation such as elastic nail, Knowles pins, rockwood pin, hybrid devices. Smekal et al which compared nail fixation and conservative treatment, found improved DASH ,constant score in the first 2 years and rapid return to ADL. This study had a few cases of nonunion and mal union only in conservative group. The present study chose elastic nail because the ease of insertion into the curved bone of clavicle and recorded date of return to work and DASH, constant score more than 2 years. The results were better than conservative treatment with no in statistical significance and found 20% of non union only in clavicle support group.

Potential conflicts of interest

The authors declare no conflict of interect.

References

1. De Giorgi S, Notarnicola A, Tafuri S, Solarino G, Moretti L, Moretti B. Conservative treatment of fractures of the clavicle. BMC Res Notes 2011;4:333.doi:1186/1756-00500-4-333.
2. Kulshrestha V, Roy T, Audige L. Operative versus nonoperative management of displaced midshaft clavicle fractures: a prospective cohort study. J Orthop Trauma 2011;25:31-8.
3. Robinson CM, Goudie EB, Murray IR, Jenkins PJ, Ahktar MA, Read EO, et al. Open reduction and plate fixation versus nonoperative treatment for displaced midshaft clavicular fractures: a multicenter, randomized, controlled trial. J Bone Joint Surg Am 2013;95:1576-84.
4. Xu J, Xu L, Xu W, Gu Y, Xu J. Operative versus nonoperative treatment in the management of midshaft clavicular fractures: a meta-analysis of randomized controlled trials. J Shoulder Elbow Surg 2014;23:173-81.
5. Wang XH, Cheng L, Guo WJ, Li AB, Cheng GJ, Lei T, et al. Plate versus intramedullary fixation care of displaced midshaft clavicular fractures: A meta-analysis of prospective randomized controlled trials. Medicine (Baltimore) 2015;94:e1792.
6. Fu B. Minimally invasive intramedullary nailing of clavicular fractures by a new titanium elastic nail. Acta Orthop Traumatol Turc 2016;50:494-500.
7. Langenhan R, Reimers N, Probst A. Intramedullary stabilisation of displaced midshaft clavicular fractures: does the fracture pattern (simple vs. complex) influence the anatomic and functional result. Z Orthop Unfall 2014;152:588-95.
8. Andrade-Silva FB, Kojima KE, Joeris A, Santos SJ, Mattar R Jr. Single, superiorly placed reconstruction plate compared with flexible intramedullary nailing for midshaft clavicular fractures: a prospective, randomized controlled trial. J Bone Joint Surg Am 2015;97:620-6.
9. Karl JW, Olson PR, Rosenwasser MP. The epidemiology of upper extremity fractures in the united states, 2009. J Orthop Trauma 2015;29:e242-4.
10. Sluys KP, Shults J, Richmond TS. Health related quality of life and return to work after minor extremity injuries: A longitudinal study comparing upper versus lower extremity injuries. Injury 2016;47:824-31.
11. Ersen A, Atalar AC, Birisik F, Saglam Y, Demirhan M. Comparison of simple arm sling and figure of eight clavicular bandage for midshaft clavicular fractures: a randomised controlled study. Bone Joint J 2015;97-B:1562-5.
12. Lenza M, Faloppa F. Conservative interventions for treating middle third clavicle fractures in adolescents and adults. Cochrane Database Syst Rev 2016;12:CD007121.
13. Woltz S, Stegeman SA, Krijnen P, van Dijkman BA, van Thiel TP, Schep NW, et al. Plate fixation compared with nonoperative treatment for displaced midshaft clavicular fractures: A multicenter randomized controlled trial. J Bone Joint Surg Am 2017;99:106-12.
14. van der Ven Denise JC, Timmers TK, Flikweert PE, Van Ijseldijk AL, van Olden GD. Plate fixation versus conservative treatment of displaced midshaft clavicle fractures: Functional outcome and patients' satisfaction during a mean follow-up of 5 years. Injury 2015;46:2223-9.
15. Smeeing DPJ, van der Ven DJC, Hietbrink F, Timmers TK, van Heijl M, Kruyt MC, et al. Surgical versus nonsurgical treatment for midshaft clavicle fractures in patients aged 16 years and older: A systematic review, meta-analysis, and comparison of randomized controlled trials and observational studies. Am J Sports Med 2017;45:1937-45.
16. Kihlstrom C, Moller M, Lonn K, Wolf O. Clavicle fractures: epidemiology, classification and treatment of 2 422 fractures in the Swedish Fracture Register; an observational study. BMC Musculoskelet Disord 2017;18:82.

17. Althausen PL, Shannon S, Lu M, O'Mara TJ, Bray TJ. Clinical and financial comparison of operative and nonoperative treatment of displaced clavicle fractures. J Shoulder Elbow Surg 2013;22:608-11.
18. van der Meijden OA, Houwert RM, Hulsmans M, Wijdicks FJ, Dijkgraaf MG, Meylaerts SA, et al. Operative treatment of dislocated midshaft clavicular fractures: plate or intramedullary nail fixation? A randomized controlled trial. J Bone Joint Surg Am 2015;97:613-9.
19. Hulsmans MH, van Heijl M, Houwert RM, Hammacher ER, Meylaerts SA, Verhofstad MH, et al. High irritation and removal rates after plate or nail fixation in patients with displaced midshaft clavicle fractures. Clin Orthop Relat Res 2017;475:532-9.
20. Rapp M, Prinz K, Kaiser MM. Elastic stable intramedullary nailing for displaced pediatric clavicle midshaft fractures: a prospective study of the results and patient satisfaction in 24 children and adolescents aged 10 to 15 years. J Pediatr Orthop 2013;33:608-13.
21. Smekal V, Irenberger A, Attal RE, Oberladstaetter J, Krappinger D, Kralinger F. Elastic stable intramedullary nailing is best for mid-shaft clavicular fractures without comminution: results in 60 patients. Injury 2011;42:324-9.