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Prospective study of internal fixation of clavicle fractures by various methods

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Abstract

Background: Fractures of the clavicle have been traditionally treated non-operatively. Although many methods of closed reduction have been described, it is recognized that reduction is practically impossible to maintain and a certain amount of deformity and disability is expected in adults. More recent data based on detailed classification of fractures, suggest that the incidence of nonunion in displaced comminuted clavicular fractures in adults is between 10 and 15%. All fractures with initial shortening of >2cm resulted in nonunion. According to Rowe a nonunion rate of 0.8-1% is seen in conservatively managed patients

Materials and Methods: This is prospective study and was carried out from September 2016 to September 2018 at Orthopedics Department in Maharajah's Institute of Medical Sciences. During this period 30 patients of clavicle fractures were treated surgically. All the patients were evaluated functionally (constant murley scoring) and radiologically for union with a follow up period of 12months

Results: Majority of the patients were with middle third clavicle fracture i.e. 26 (87%) patients. road traffic accidents were the most common mode of injury with males 18 (60%) predominant and left side(60%) being the commonest side involved in this study. Majority of the cases were operated less than 10 days. Radiological union observed in 8-12 weeks in 29 (97%) cases, 26 (86%) cases had excellent functional outcome at final follow up.

Conclusion: This study concluded that primary open reduction and internal fixation with plate and screws for displaced middle third clavicle fractures provides a more rigid fixation and does not require immobilization for longer periods. It helps in getting back to daily activities and early mobilization.

Keywords: clavicle fractures, surgical management

Introduction

Clavicle is the only long bone to lie horizontally in the body. It is the only bone with membranous ossification. It is the first bone to ossify in the body. The shaft ossifies from two primary centers. It lacks a well -defined medullary cavity. It is subcutaneous throughout its whole extent.

Clavicle is the bony link from thorax to shoulder girdle and contributes to movements at the shoulder girdle. Clavicle fracture is a common traumatic injury around shoulder girdle due to their subcutaneous position. It is caused by either low-energy or high-energy impact. Fracture of the clavicle accounts for approximately 2.6% to 5% of all fractures and up to 35% of injuries to the shoulder girdle. About 70% to 80% of these fractures are in the middle third of the bone and less often in the lateral third (12% to 15%) and medial third (5% to 8%)^[1, 2].

Several studies have examined the safety and efficacy of primary open reduction and internal fixation for completely displaced fractures clavicle and noted high union rate with a low complication rate. There are various methods for treating clavicle mid shaft fractures such as pre contoured clavicular locking plates, reconstruction plates, dynamic compression plates, intramedullary nails etc.^[2, 3].

For lateral third clavicular fracture operative treatments include trans acromial Kirschner wire, cancellous compression screw and coraco clavicular screw. AO/ASIF group has recommended the use of tension band wire construct for fixation of displaced lateral third clavicle fracture^[3]. The proponents of early fixation of fresh clavicular fractures to prevent complications like

malunion and non-union emphasize the value of accurate reduction and rigid fixation in affording quick pain relief and promoting early functional recovery⁴. The purpose of this study is to evaluate the role of open reduction and internal fixation in clavicle fractures and to evaluate the results of surgically managed fresh displaced, comminuted middle third clavicle fractures with plate and screws and Kirschner wires with tension band construct for displaced lateral third clavicle fractures.

Materials and Methods

A prospective study and was carried out from September 2016 to September 2018 at Orthopedics Department in MIMS Medical college. During this period 30 patients of clavicle fractures were admitted, evaluated and treated surgically with prior consent and ethics committee approval.

Inclusion criteria

1. Age between 18 and 60 years.
2. All clavicle fractures with neurovascular deficit.
3. All displaced or comminuted fractures.
4. All fractures with tenting of skin.
5. All clavicular fractures with >20mm bone loss.

Exclusion criteria

1. Age < 18 years and >60 years
2. Pathological fractures
3. Undisplaced fractures
4. Associated head injury
5. Any medical contraindication to surgery or general anaesthesia (heart diseases, renal failure or active chemotherapy)
6. Lack of consent

We followed the most commonly used system of classification of clavicular fractures that of Allman^[5]. It is divided into 3 groups.

Group I: Middle-third fractures

Group II: Lateral-third fractures.

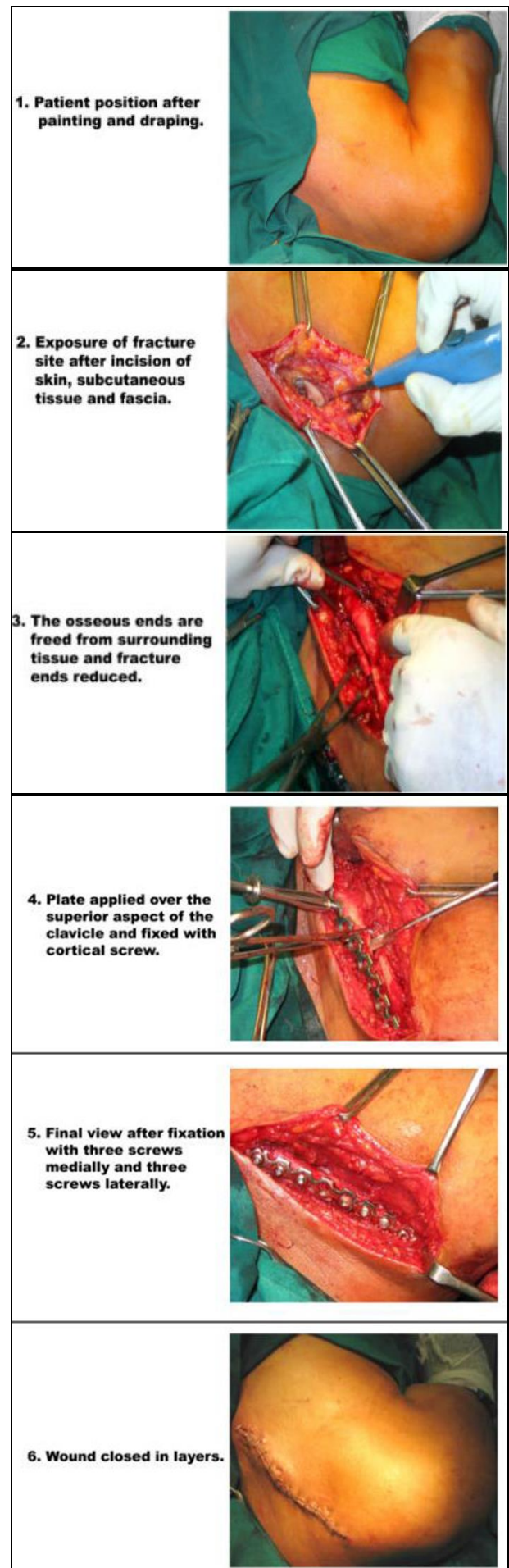
Group III: Medial- third fractures

After admission thorough physical assessment of general condition of the patient was done, necessary investigations, x-rays were done. All patients were explained about their condition. Informed consent was taken from all the patients.

Surgical technique: Patient position- beach chair position with one towel in between the scapula. Entire upper limb from base of neck to hand were prepared and draped. About 7-9 cm, incision was made in the anterior aspect centering of clavicle over the fracture site. The skin, subcutaneous tissue and Platysma were divided without undermining the edges. The overlying fascia and periosteum were next divided. The osseous ends were freed from surrounding tissue. Minimal soft tissue and periosteum dissection was done. Fracture fragments were reduced, provisionally held with k-wires and plate was applied over the superior aspect of the clavicle. At the junction of the medial and middle third of the clavicle, the inferior surface is exposed so that a protective instrument can be inserted during drilling to prevent injury to neurovascular structure underneath it. The pre contoured locking plate or recon plate/ DCP was fixed to the medial and lateral fragment with locking screws/ cortical screws and at least three screws in medial and lateral fragment were applied.

For Intramedullary nailing an entry point into medial or

lateral end of clavicle and progressed under c-arm control.



Post operatively patients were managed with Intravenous fluids, antibiotics, analgesics and tranquilizers were given according to the needs of the patient. The operated upper limb was immobilized in an arm pouch. The wound was inspected at 3rd or 4th postoperative day. Suture/ staple removal was done on 10th postoperative day. Patients were discharged with the arm pouch.

Rehabilitation of the affected arm was started at the end of 2 weeks. Gentle pendulum exercises to the shoulder in the arm pouch were allowed. At 4 to 6 weeks gentle active range of motion of the shoulder was allowed but abduction in limited to 80 degrees. At 6 to 8 weeks active range of motion in all

planes were allowed.

Regular follow up for every 4 weeks was done. Local examination of the affected clavicle for tenderness, instability deformity and shoulder movements were assessed. X-rays were taken at each follow up visits to known about progressive fracture union and implant position. Patients were followed up till radiological union.

The functional outcome was assessed by Constant and Murley score^[6].

Results

Table 1: Age Incidence

Age in years	No. of Middle third clavicle fracture	%	No. of Lateral third clavicle fracture	%
19-29	12	40	3	10
30-39	8	27	1	3
40-49	2	7		
50-59	4	13		
Total	26	87%	4	13%

Majority of the patients were with middle third clavicle fracture i.e. 12 patients (40%) were in the age group of 19-29 years. The youngest patient was 19 years and oldest patient was 59 years. The average patient age was 34 years. Most

patients 3 cases (10%) with lateral third clavicle fracture were between 19-29 years. The youngest patient was 22 years and oldest patient was 31 years with average age of 26 years.

Table 2: Sex Incidence

Age in years	No. of Middle third clavicle fracture	%	No. of Lateral third clavicle fracture	%
Male	17	57%	1	3%
Female	9	30%	3	10%
Total	26	87%	4	13%

In middle third clavicle fracture the majority was males, 17 patients (57%) and females were 9 patients (30%).

In lateral third clavicle fracture out of 4 patients 3 were female (10%) and males were 1 patient (3%)

Table 3: Mode of Injury

Mode of injury	No. of Middle third clavicle fracture	%	No. of Lateral third clavicle fracture	%
Road traffic accident	21	70	2	7
Simple fall on shoulder	3	10	1	3
Fall on outstretched hand (indirect)	2	7	1	3
Total	26	87	4	13

In Middle third clavicle fractures direct injury occurred in 24 patients (80%) among them 21 patients (70%) were due to road traffic accident, 3 patients (10%) were due to fall on the shoulder after slipping. Indirect injury occurred in 2 patients (7%) due to fall on outstretched hand.

In lateral third clavicle fracture the direct injury occurred in 3 patients (10%) among them 2 patients (7%) were due to road traffic accident, 1 patient (3%) were due to fall on the shoulder after slipping. Indirect injury occurred in 1 patient (3%) due to fall on outstretched hand.

Table 4: Site of Fracture

Site of clavicle fracture	Number of cases	Percentage
Middle third	26	87%
Lateral third	4	13%
Medial third	0	0

In this present study there were 26 patients (87%) of middle third clavicle fracture and 4 patients (13%) were lateral third clavicle fracture and there were no medial third clavicle

fracture.

All the patients in both middle and lateral third clavicle fracture were closed type. There was no associated medical illness in any patient.

Table 5: Side Affected

Right involved	No. of Middle third clavicle fracture	%	No. of Lateral third clavicle fracture	%
Right	10	33%	2	7%
Left	16	53%	2	7%
Total	26	86%	4	14%

In this study for middle third clavicle fractures there were 16 patients (53%) of Left sided fracture and 10 patients (33%) of Right sided fracture.

For Lateral third clavicle fracture there were 2 patients (7%) on the left side and 2 patients (7%) on the Right side.

Time interval for surgery

All the patients were operated as early as possible once the

general condition of the patients was stable.

Table 6: All the patients were operated as early as possible once the general condition of the patients was stable

Time of surgery	No. of Middle third clavicle fracture	%	No. of Lateral third clavicle fracture	%
< 7 days	23	77%	4	13%
7-14 days	3	10%	0	0
Total	26	87%	4	13%

In middle third clavicle fracture 23 patients (77%) were operated in the first week and 3 patients (10%) were operated in the second week due to fixed OT days in MIMS medical college.

In lateral third clavicle fracture all the 4 patients (13%) under gone surgery within 1 week.

All the patients were operated under general anaesthesia

Types of Implant

The middle third fracture is fixed with plate and cortical screws and intra medullary nails. The following types of implants are used.

Table 7: The following types of implants are used.

Type of plate	No. of cases	%
Pre contoured plate	16	53%
Reconstruction plate	11	37%
Dynamic compression plate	2	7%
IM nails	1	3%

Table 9: The functional outcome is assessed by Constant and Murley score.

Functional outcome	No. of Middle third clavicle fracture	%	No. of Lateral third clavicle fracture	%
Excellent	23	76%	2	7%
Good	3	10%	0	0
Fair	0	0%	2	7%
Poor	0	0	0	0
Total	26	86%	4	14%

In this study on 26 patients (86%) with middle third clavicle fracture treated with plate and screws and IM nails 23 patients (76%) had excellent functional outcome, good functional outcome in 3 patients (10%)

For 4 patients of lateral third clavicle fracture fixed 2 patients (7%) had excellent functional outcome results and 2 patients (7%) had fair functional outcome.

Complications

Major complication: A complication requiring inpatient treatment and resulting in an additional morbidity of 2 months or more was regarded as a major complication.

Table 10: For middle third clavicle fracture

	Types	No. of cases	%
Minor	Hypertrophic skin scar	6	20%
	Plate prominence	4	13%
	Delayed union	1	3%
	Plate loosening/superficial infection	1	3%
Major	Plate breakage	0	0

In middle third clavicle fixation 6 patients (20%) had hypertrophic skin scar and in 4 patients (13%) plate prominence occurred. In 1 patients (3%) delayed union occurred. In 1 patient (3%) plate loosening/superficial infection occurred which went for malunion.

In 16 patients (53%) pre contoured plates were used. In 11 patients (37%) reconstruction plates were used. In 2 patients (7%) dynamic compression plates were used, in 1 patients (3%) IM nails were used. Commonly pre contoured plates were used.

Duration of Union

The fracture was considered to be united when clinically there was no tenderness, radiologically the fracture line was not visible and full unprotected function of the limb was possible.

Table 8: Middle and lateral third clavicle fracture

Time of union	No. of Middle third clavicle fracture	%	No. of Lateral third clavicle fracture	%
8-12 weeks	25	84%	4	13%
>12weeks	1	3%	0	0
Total	26	87%	4	13%

In middle third clavicle fracture 25 patients (84%) united at the end of 12 weeks. In 1 patients (3%) delayed union occurred. In 1 patients it was due to large butterfly fragment at fracture site which united at 14 weeks.

In lateral third all the 4 patients united at the end of 12 weeks.

Functional Outcome

The functional outcome is assessed by Constant and Murley score.

Table 11: For lateral third clavicle fracture

	Type of complications	No. of cases	%
Minor	Superficial infection	2	7%
Major	Restriction of shoulder movements	2	7%

In 2 patients (7%) superficial infection occurred which was treated with oral antibiotics for 5 days and in another 2 patients (7%) restriction of shoulder movements. The patient was notable to follow the shoulder exercises because of pain.





Case-1: pre-op immediate post op 1month post op



6 months post op ROM at final follow up



Case-2 Pre op Immediate post op 1month postop



Clinical pictures showing ROM of patients

Case-3



3months post op 6months post op



Pre-op immediate post op



Hypertrophic scar Case-4



1 month post op 6 months post op



Pre op post op





1 month post op 6 months post op



Pre-op immediate post op 1 month post op



Clinical pictures with range of motion



6months post op superficial infection



Case-5





Clinical pictures showing range of movements

Discussion

Good results with excellent union and low complication rates were seen in numerous studies done on primary fixation of clavicle fractures negating the pessimism that surrounded prior studies where a poor understanding of soft tissue handling, selection bias of patients and inadequate implants combined to produce inferior results.

Recent studies show increasing evidence that non-operative treatment of displaced, comminuted mid shaft fractures of clavicle was not as optimal as once thought. Non-union rates, strength and endurance deficits are common in cases treated conservatively.

Zlowodzki *et al.*^[7] in a meta-analysis of literature found that the non-union rate of clavicles treated non-operatively was 15.1%, much higher than that was described earlier by Neer^[8] (0.1%). Stanley and Norris^[9] stated that 33% of patients treated conservatively had symptoms 3 months after fracture. Sankarankutty and Turner reported 15% of patients with deformity at the fracture site in 100 cases treated non-operatively.

Displaced fractures of the clavicle can never be treated the same way as undisplaced or minimally displaced fractures for the deforming pull of the Sternocleidomastoid is too great and that the deformity recurs shortly after figure of eight bandage. It has been shown that mid third clavicle fractures with > 2 cm displacement or 15 mm shortening are at increased risk of non-union.

Thompson^[10] reviewed 100 cases of mid clavicular non unions and found that 90% of the original fractures had displacement > 100%, overriding > 1 cm or had severe comminution, thus necessitating surgical stabilization.

Plate fixation provides immediate pain relief and stabilization, facilitates early mobilization and early return to pre injury activities.

A multicentric trial conducted by Canadian orthopedic trauma society^[11] on 111 patients showed good overall shoulder function, rapid recovery and relief of pain with lower malunion and non union rates and a shorter overall union time in clavicular fractures treated with plating.

Kaisa *et al.*^[12] in a study comparing sling with plate osteosynthesis for displaced clavicular fractures found that operative stabilization to be a reliable method with low complication rate and high union rate. He also noted that non operative treatment resulted in a higher non union rate of 24%.

Clavicle fractures are usually treated conservatively. In a study conducted to analyze the results of conservative treatment by Hill *et al.*^[13] in 1997, Nordqvist *et al.*^[14] In 1998 Robinson *et al.*^[15] found poor results following conservative treatment of displaced middle third clavicle fracture.

Conservative treatment of displaced lateral third clavicle fracture has higher rate of non union and residual shoulder dysfunction as showed by Edwards *et al.*^[16].

The present study of patients with middle third clavicle fractures is compared with Bostman *et al.*^[17] study, which treated only middle third clavicle fractures, in this totally 103 patients were treated by early open reduction and internal fixation with plate and screws. Also compared with lokesh H, *et al.*^[18] study which includes both middle and lateral third clavicular fractures.

Mechanism of injury

In this study the most common cause of fracture is Road traffic accident in 21 patients (70%), comparable to Bostman *et al.*^[17] study the mechanism of injury was due to fall from the two wheeler in 38 Patients (36.8%), and lokesh H, *et al.*^[18] study middle third fractures 32 (80%), due to fall on shoulder from two wheeler.

Age incidence

Majority of the patients were with middle third clavicle fracture i.e. 12 patients (40%) were in the age group of 19-29 years. The average patient age was 34 years (19-59 years) which is comparable to Bostman *et al.*^[17] Study patients average age was 33.4 years and lokesh H, *et al.*^[18] study average age was 35.65 years.

Most patients 3 cases (10%) with lateral third clavicle fracture were between 19-29 years with average age of 26 years, In lokesh H *et al.* Most patients 3 cases (7.5%) with lateral third clavicle fracture was between 30-39 years with an average of 37.5 years the youngest patient was 27 years and oldest was 57 years.

Sex incidence

In middle third clavicle fracture the majority was males, 17 patients (57%) and females were 9 patients (30%). In Bostman *et al.*^[17] Series also commonly males are affected 76 Patients (73.79%) compared to females 27 patients (26.21%).

In lateral third clavicle fracture out of 4 patients 3 were female (10%) and males were 1 patient (3%) This is comparable to Kao FC *et al.*^[19] study which also shows male preponderance i.e. males (66.67%) and females (33.33%).

In lokesh H, *et al.*^[18] study in middle third clavicular fractures majority were males 28 (70%), females were 4 (10%). In lateral third clavicular fractures majority were males 6 (15%), females were 2 (5%).

Type of fracture

In this study all patients with middle third and lateral third clavicle fractures were of closed type, this is comparable to Bostman *et al.*^[17] Study and lokesh h. *et al.*^[18] in which also showed all their patients were closed fractures.

In Kao *et al.*^[19] study also all the patients are closed type.

Time interval for surgery

Most of the patients in present study were operated in the first week i.e. 27 Patients (90%). 3 patients (10%) were operated in the second week due to fixed OT days in MIMS General Hospital.

In Bostman *et al.*^[17] Study all the patients were operated within 3 days of injury.

Types of implant

In this study In 16 patients (53%) pre contoured plates were

used. In 11 patients (37%) reconstruction plates were used. In 2 patients (7%) dynamic compression plates were used, in 1 patients (3%) IM nails were used. Commonly pre contoured plates were used as it gave stable fixation.

This in comparison with Bostman *et al.* [17]. Study was reconstruction plates were used in 46 patients (44.66%). Dynamic compression plates were used in 55 patients (53.40%) and semi tubular plates in 2 patients (1.94%). In lokesh H, *et al.* [18] study locking compression plates were used in 20 patients (50%), reconstruction plates in 6 patients (15%), dynamic compression plates in 6 patients (15%), commonly locking compression plates were used.

Duration of union

In middle third clavicle fracture 25 patients (84%) united at the end of 12 weeks. In 1 patients (3%) delayed union occurred. In 1 patients it was due to large butterfly fragment at fracture site which united at 14 weeks.

Lazarus MD [16] stated radiological union occurred approximately between 6 to 12 weeks. In lateral third all the 4 patients united at the end of 12 weeks

In Kao *et al.* [19]. Series union occurred after an average period of 4 months (range 3-6 months).

In lokesh H, *et al.* [18] study in middle third clavicular fractures, 28 patients (70%) united at the end of 12 weeks. In 4 patients (10%) delayed union occurred. It was due to large butterfly fragment at fracture site which united at 16 weeks. In lateral third 7 patients united at end of 12 weeks. In one patient (treated with hook plate) united at the end of 14 weeks.

Functional outcome

The functional outcome according to Constant and Murley in this study of total 26 patients of fresh middle third clavicle fracture fixed with plate and screws showed excellent results in 23 patients (76%) and good functional outcome in patients 3 patients (10%).

Out of 4 patients fixed with lateral 3rd fractures, 2 patients had excellent functional outcome and 2 patients had fair functional outcome due to restriction of shoulders movements in that patients.

In lokesh H *et al.* [18], study 32 patients (80%) middle third clavicular fractures treated with plate and screws 24 patients (60%) had excellent functional outcome, good functional outcome in 6 patients (15%) and fair functional outcome in 2 patients (5%). For 8 patients of lateral third clavicle fracture fixed with Kirschner wire and tension band wire 4 patients (10%) had excellent functional outcome results and 2 patients (5%) had good functional outcome 1 patient had fair functional outcome and with 1 patient fixed with 4 hole hook plate had fair functional outcome due to associated scapula body fracture

The advantage of rigid internal fixation and early mobilization of fresh displaced clavicle fracture is that it (displaced comminuted middle third and displaced lateral third clavicle fracture) gives immediate pain relief and prevents the development of shoulder stiffness and non-union.

Conclusion

This study concluded that primary open reduction and internal fixation with plate and screws for displaced or comminuted middle third or lateral third clavicle fractures treated surgically gave excellent results in 25 (83%) patients and does not require immobilization for longer periods. Precontoured anatomical locking plates are associated with less hardware related problems than with reconstruction plate or DCP plate.

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Results	Lokesh. H <i>et al.</i>	Present study
Excellent	70	83
Good	20	10
Fair	10	7
Poor	0-	0-

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