International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2017; 3(3): 1050-1061

www.orthopaper.com
Received: 23-05-2017
Accepted: 24-06-2017

Dr. Balachandar S
Assistant Professor,
Department of Orthopedics,
Government Omandurar Medical College, Tamil Nadu, India

Dr. Mohankumar K
Associate Professor,
Department of Orthopedics,
Government Stanley Medical College, Tamil Nadu, India

Dr. Kathir Azhagan S
Resident Department of Orthopedics, Government Stanley Medical College,
Tamil Nadu, India

Correspondence
Dr. Mohankumar K
Associate Professor,
Department of Orthopedics,
Government Stanley Medical College, Tamil Nadu, India

Outcome of plate and intramedullary fixation of midshaft clavicle fractures: A search for optimal surgical management

Dr. Balachandar S, Dr. Mohankumar K and Dr. Kathir Azhagan S

DOI: https://doi.org/10.22271/ortho.2017.v3.i3o.153

Abstract
Middle third clavicle fractures are one of the most common types of fractures especially in young adults. But management part is still under debate. In olden days most of the fractures managed by conservative methods by arm sling and figure of eight bandage. But increasing demands, early mobilization of patients and anatomical fixation nowadays these fractures are managed by Open Reduction and Internal Fixation with plates and screws and Closed Reduction and Internal Fixation with Titanium Elastic Nailing System (TENS).In our study 15 patients treated with ORIF with plating, another 15 patients treated with CRIF/ORIF with elastic nailing. Though each procedure having advantages and disadvantages the functional outcome of surgical methods found to be better when compared to conservative methods. Elastic nailing not indicated for comminuted fractures and fracture nonunion. The advantage of intra medullary fixation and not disturbing the fracture hematoma are additive features of closed nailing.

Keywords: Plate, intramedullary fixation, midshaft clavicle fractures

Introduction
The clavicle or collar bone is an S-shaped long bone which by its horizontal orientation forms a strut between the sternum and the scapula. A fracture of clavicle is one of the most common bony injuries rarely requires open reduction. In 94% of 122 patients with clavicular fractures, Stanley *et al*. found the mechanism of injury to be consistent with a direct blow rather than a fall on the outstretched hand, which is widely believed to be the most common mechanism of injury. In Neer's series of 45 fractures treated by open reduction, nonunion occurred in two (4%). Rowe reported nonunion in 0.8% of fractures treated by closed methods and in 3.7% treated by open reduction. Although displaced fractures of the clavicle often cannot be reduced and maintained in perfect position, cosmesis is acceptable and functional results are uniformly excellent. Even if the ends of the fragments heal in an overlapped or bayonet position with a substantial bony prominence, this is largely resorbed with time, and the mass decreases. Even the most fastidious patient usually is satisfied with the results.

Aims and Outline
This series aim to study the functional outcome of midshaft clavicle fractures managed by ORIF with plating and CRIF/ ORIF with TENS.

Materials and Methods
This is a prospective study of 30 cases of midshaft clavicular fractures treated by ORIF with plating and CRIF/ORIF with TENS nailing. Patients were explained about the procedures, complications and postoperative protocols. Informed consent has been obtained from all patients. The period of study and follow up extends from August 2014 to August 2015, in the Department of Orthopedics, Stanley Medical College, Chennai.

Inclusion Criteria
1. Age- 17 years and above
2. Displaced midshaft clavicle fractures

3. Soft tissue compromise(tenting of skin) at the level of fracture
4. Associated injuries

Exclusion Criteria

1. Age less than 17
2. Fracture involving proximal and distal third
3. Severely comminuted fractures
4. Open fractures
5. Old fracture nonunion
6. Pathological fractures

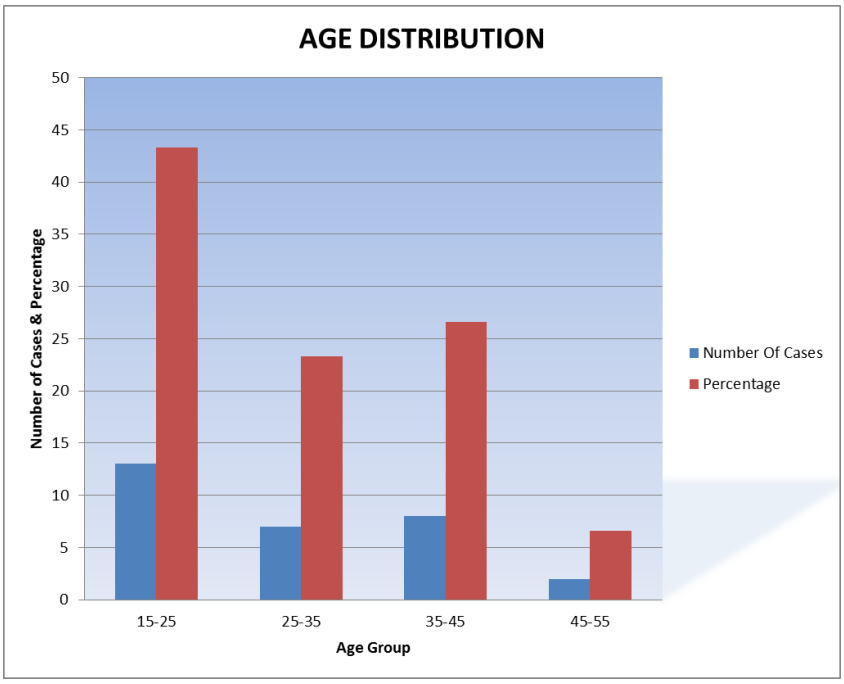
Observation and Analysis

All the cases were analyzed as per the following criteria:

1. Age distribution
2. Sex distribution
3. Side of injury
4. Mode of injury
5. Fracture type
6. Method of treatment(Plating/ Nailing)
7. Time duration between injury and surgery
8. Associated injuries
9. Complications
10. Duration of hospital stay
11. Plate size and Nail size
12. Need for implant exit

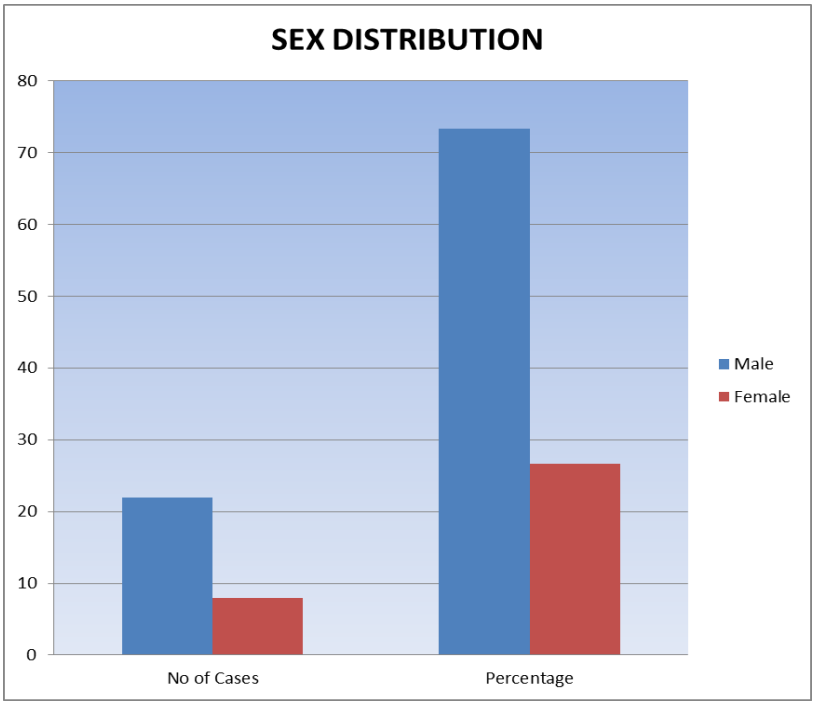
I. Age Distribution

Commonest age group 15-25 years.

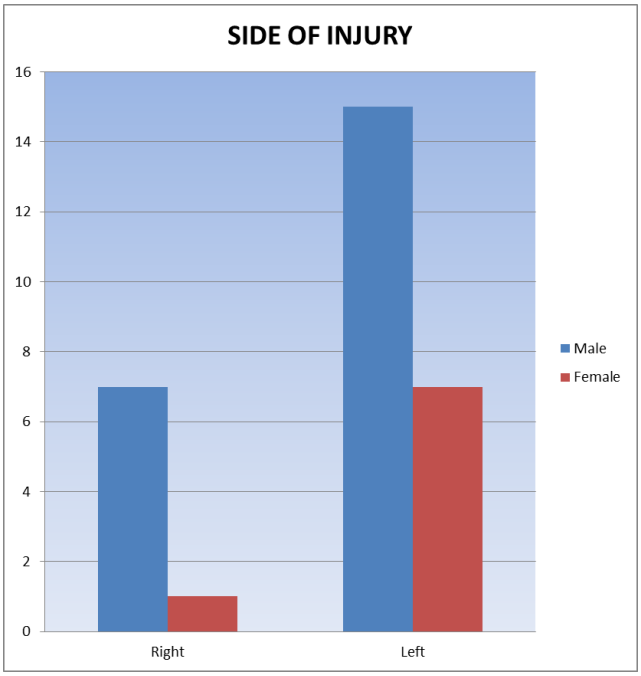


II. Sex Distribution

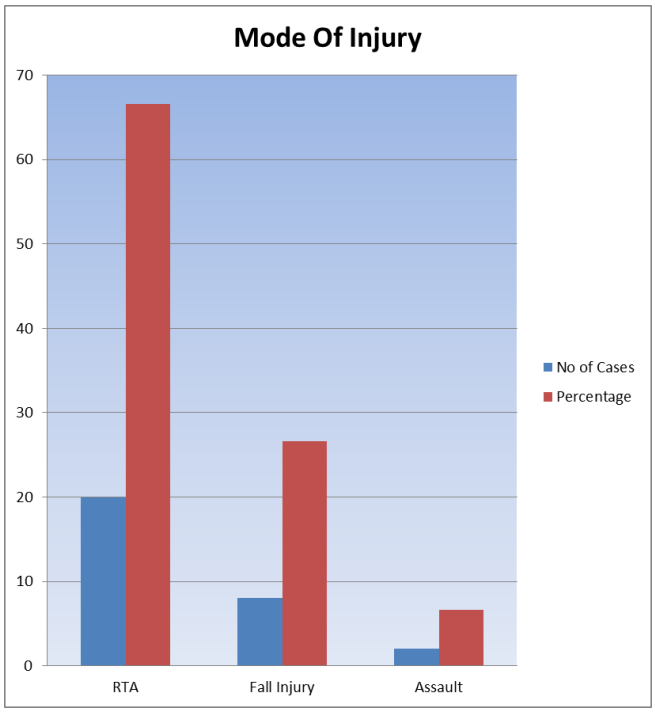
Among 30 cases, males are predominant.



III. Side of Injury
Left side was more common in our study



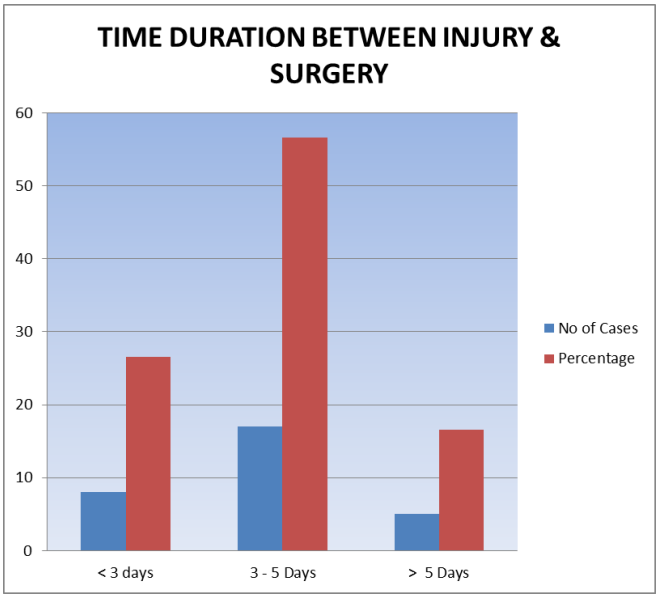
IV. Mode of Injury
Most common mode of injury was Road Traffic Accident in our study.



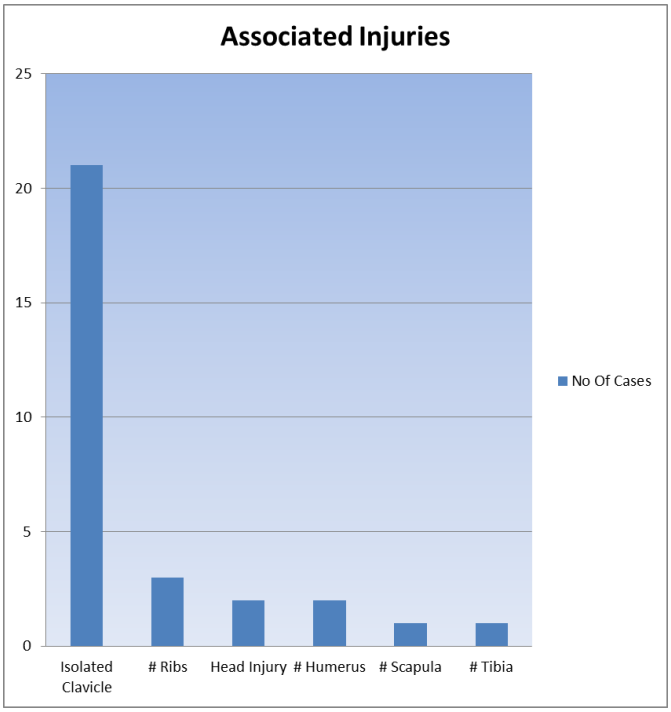
V. Fracture Type – Allman Group I injuries
VI. Method Of Treatment:

1. 15 cases selected for ORIF with Plating
2. 15 cases selected for CRIF/ ORIF with Elastic Nailing

VII. Time Duration between Injury and Surgery
Most of the cases done between 3 to 5 days in our study.



VIII. Associated Injuries
Isolated Clavicle Injuries more common in our study



IX. Complications

1: ORIF with Plating

S. No	Complications	No. Of Cases
1	Infection	2
2	Delayed Union	3
3	Stiff Shoulder	3

2: CRIF/ ORIF with Elastic Nailing

S. No	Complications	No. Of Cases
1	Skin Irritation	2
2	Delayed Union	1
3	Nail Migration	1

X. Duration of Hospital Stay

Procedure	Duration of Stay
ORIF with Plating	5 – 7 Days
CRIF/ ORIF with Nailing	3 – 5 Days

XI. Plate and Nail Size Used

1. Locking Plate (Anatomical Plate) Used – 4
2. 3.5 mm Reconstruction Plate Used – 11
3. 2.5 mm TENS Nail Used – 12
4. 2 mm TENS Used – 3

XII. Need for Implant Exit

Among 15 cases operated with ORIF with plating 2 cases got infected, clinically infection found to be superficial. Clinical and radiological evidence of union was noted. Implant exit done after 20 weeks, infection settled down after removal of implant.

Among 15 cases operated with elastic nailing implant exit done for 9 cases after confirming clinical and radiological evidence of union. Implant exit done as a outpatient procedure under local anaesthesia.

Results

Results	Plating (15)	Elastic Nail (15)
Union in anatomical position	15	15
Union in 12 weeks	11	14
Union in 16 weeks	4	1
Nonunion	Nil	Nil
Malunion	Nil	Nil
Early return to activity	28 days (11 cases)	14 days (14 cases)
Stiffness of shoulder	3	Nil
Loss of length of clavicle (shortening > 2cms)	Nil	Nil
Patient compliance and functional outcome	Excellent-8 cases Good-4 cases Moderate-3 cases Poor-Nil	Excellent-12 cases Good- 2 cases Moderate-1 case Poor-Nil
Other Complications	Infection-2 cases Stiffness of shoulder-3 Hypertrophied Scar-3	Nail migration-1 case Skin irritation-2 cases Infection-Nil

Biostatistics

Age Distribution

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Age	Plating	15	28.80	12.330	3.184
	Elastic Nail	15	33.20	9.443	2.438

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Age	Equal variances assumed	2.526	.123	-1.097	28	.282	-4.400	4.010	-12.614	3.814
	Equal variances not assumed			-1.097	26.219	.283	-4.400	4.010	-12.639	3.839

Sex Distribution

Crosstab

			Group		Total
			Plating	Elastic Nail	
Sex	Male	Count	12	10	22
		% within Group	80.0%	66.7%	73.3%
	Female	Count	3	5	8
		% within Group	20.0%	33.3%	26.7%
Total		Count	15	15	30
		% within Group	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.682[b]	1	.409		
Continuity Correction[a]	.170	1	.680		
Likelihood Ratio	.687	1	.407		
Fisher's Exact Test				.682	.341
Linear-by-Linear Association	.659	1	.417		
N of Valid Cases	30				

a. Computed only for a 2x2 table

b. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 4.00.

Side Distribution

Crosstab

			Group		Total
			Plating	Elastic Nail	
Side	Right	Count	5	4	9
		% within Group	33.3%	26.7%	30.0%
	Left	Count	10	11	21
		% within Group	66.7%	73.3%	70.0%
Total		Count	15	15	30
		% within Group	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.159[b]	1	.690		
Continuity Correction[a]	.000	1	1.000		
Likelihood Ratio	.159	1	.690		
Fisher's Exact Test				1.000	.500
Linear-by-Linear Association	.153	1	.695		
N of Valid Cases	30				

a. Computed only for a 2x2 table

b. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 4.50.

Mode of Injury

Crosstab

			Group		
			Plating	Elastic Nail	Total
Mode of injury	RTA	Count	11	9	20
		% within Group	73.3%	60.0%	66.7%
	Assault	Count	1	1	2
		% within Group	6.7%	6.7%	6.7%
	Fall	Count	3	5	8
		% within Group	20.0%	33.3%	26.7%
Total		Count	15	15	30
		% within Group	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.700[a]	2	.705
Likelihood Ratio	.706	2	.703
Linear-by-Linear Association	.667	1	.414
N of Valid Cases	30		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is 1.00.

Associated injury

Crosstab

			Group		
			Plating	Elastic Nail	Total
Associated injury	Isolated	Count	13	8	21
		% within Group	86.7%	53.3%	70.0%
	Head injury	Count	1	1	2
		% within Group	6.7%	6.7%	6.7%
	Ribs	Count	1	2	3
		% within Group	6.7%	13.3%	10.0%
	Tibia	Count	0	1	1
		% within Group	.0%	6.7%	3.3%
	Humerus	Count	0	2	2
		% within Group	.0%	13.3%	6.7%
	Scapula	Count	0	1	1
		% within Group	.0%	6.7%	3.3%
Total		Count	15	15	30
		% within Group	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.524[a]	5	.355
Likelihood Ratio	7.087	5	.214
Linear-by-Linear Association	5.151	1	.023
N of Valid Cases	30		

a. 10 cells (83.3%) have expected count less than 5. The minimum expected count is .50.

Time of Plating/ nailing (days)

Crosstab

			Group		
			Plating	Elastic Nail	Total
Time of plating/ nailing (days)	< 3	Count	4	4	8
		% within Group	26.7%	26.7%	26.7%
	3 - 5	Count	8	9	17
		% within Group	53.3%	60.0%	56.7%
	> 5	Count	3	2	5
		% within Group	20.0%	13.3%	16.7%
Total		Count	15	15	30
		% within Group	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.259[a]	2	.879
Likelihood Ratio	.260	2	.878
Linear-by-Linear Association	.076	1	.783
N of Valid Cases	30		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is 2.50.

Reduction during Surgery

Crosstab

			Group		
			Plating	Elastic Nail	Total
Reduction during surgery	ORIF	Count	15	6	21
		% within Group	100.0%	40.0%	70.0%
	CRIF	Count	0	9	9
		% within Group	.0%	60.0%	30.0%
Total		Count	15	15	30
		% within Group	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	12.857[b]	1	.000		
Continuity Correction[a]	10.159	1	.001		
Likelihood Ratio	16.462	1	.000		
Fisher's Exact Test				.001	.000
Linear-by-Linear Association	12.429	1	.000		
N of Valid Cases	30				

a. Computed only for a 2x2 table

b. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 4.50.

Maximum adjusted score (0-No/ 100- extreme difficulty)

Crosstab

			Group		
			Plating	Elastic Nail	Total
Maximum adjusted score (0-No /100-extreme difficulty)	0	Count	10	11	21
		% within Group	66.7%	73.3%	70.0%
	10	Count	0	3	3
		% within Group	.0%	20.0%	10.0%
	20	Count	1	1	2
		% within Group	6.7%	6.7%	6.7%
	40	Count	2	0	2
		% within Group	13.3%	.0%	6.7%
	50	Count	2	0	2
		% within Group	13.3%	.0%	6.7%
Total		Count	15	15	30
		% within Group	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.048[a]	4	.133
Likelihood Ratio	9.752	4	.045
Linear-by-Linear Association	3.014	1	.083
N of Valid Cases	30		

a. 8 cells (80.0%) have expected count less than 5. The minimum expected count is 1.00.

Functional Outcome

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Mobilization Started in days	Plating	15	15.87	3.204	.827
	Elastic Nail	15	5.53	6.357	1.641
Clinical union in weeks	Plating	15	9.60	1.595	.412
	Elastic Nail	15	7.27	1.668	.431
Radio. Union in weeks	Plating	15	12.07	2.344	.605
	Elastic Nail	15	9.47	2.066	.533

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mobilization Started in days	Equal variances assumed	1.181	.286	5.622	28	.000	10.333	1.838	6.568	14.098
	Equal variances not assumed			5.622	20.682	.000	10.333	1.838	6.507	14.159
Clinical union in weeks	Equal variances assumed	.103	.751	3.917	28	.001	2.333	.596	1.113	3.554
	Equal variances not assumed			3.917	27.944	.001	2.333	.596	1.113	3.554
Radio. Union in weeks	Equal variances assumed	.795	.380	3.223	28	.003	2.600	.807	.948	4.252
	Equal variances not assumed			3.223	27.563	.003	2.600	.807	.946	4.254

Mann-Whitney Test

Ranks

	Group	N	Mean Rank	Sum of Ranks
Mobilization Started in days	Plating	15	21.27	319.00
	Elastic Nail	15	9.73	146.00
	Total	30		
Clinical union in weeks	Plating	15	20.87	313.00
	Elastic Nail	15	10.13	152.00
	Total	30		
Radio. Union in weeks	Plating	15	20.87	313.00
	Elastic Nail	15	10.13	152.00
	Total	30		

Test Statistics[b]

	Mobilization Started in days	Clinical union in weeks	Radio. Union in weeks
Mann-Whitney U	26.000	32.000	32.000
Wilcoxon W	146.000	152.000	152.000
Z	-3.708	-3.433	-3.426
Asymp. Sig. (2-tailed)	.000	.001	.001
Exact Sig. [2*(1-tailed Sig.)]	.000[a]	.000[a]	.000[a]

a. Not corrected for ties.

b. Grouping Variable: Group

Complications

Complication * Group Crosstabulation

			Group		Total
			Plating	Elastic Nail	
Complication		Count	10	11	21
		% within Group	66.7%	73.3%	70.0%
	Delayed union	Count	1	1	2
		% within Group	6.7%	6.7%	6.7%
	Delayed union& Shoulder stiffness	Count	1	0	1
		% within Group	6.7%	.0%	3.3%
	Delayed union& stiffness	Count	1	0	1
		% within Group	6.7%	.0%	3.3%
	Delayed union, Infection & stiffness	Count	1	0	1
		% within Group	6.7%	.0%	3.3%
	Infection	Count	1	0	1
		% within Group	6.7%	.0%	3.3%
	Nail migration	Count	0	2	2
		% within Group	.0%	13.3%	6.7%
	Skin irritation	Count	0	1	1
		% within Group	.0%	6.7%	3.3%
Total		Count	15	15	30
		% within Group	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.048[a]	7	.424
Likelihood Ratio	9.752	7	.203
N of Valid Cases	30		

a. 14 cells (87.5%) have expected count less than 5. The minimum expected count is .50.

Discussion

Clavicle fractures are one of the most common fractures of young active individuals. Most of the clavicle fractures managed by conservative method previously but after understanding the fracture biomechanics of clavicle surgical management found to have good functional outcome and early mobilization of patients. Fracture patterns like displaced, comminuted, shortening>2 cm all have impact on union and functional outcome.

In our study we evaluated 30 cases of midshaft clavicular fractures treated by ORIF with plating (15 cases) and titanium elastic nailing (15 cases). Functional outcome in terms of early mobilization, clinical union and radiological union found to be significant with p-value of (.000), (.001) and (.001) respectively (All values less than <0.05). Hence patients treated with elastic nailing had good functional outcome and good anatomical reduction.

Analysis of Various Studies

Previous literatures and studies compared the functional outcome of conservative methods and plating, conservative methods and nailing. But only small numbers of studies were comparing plating versus nailing. Our study compared the functional outcome of plating versus nailing.

	Zlodowski *et al* (2005) 2144 cases			**Thiyagara- jan *et al* (2005)**		**Zlodowski *et al* (2007)**		**Smekal *et al* (2009) 60cases**		**Chen QY *et al* (2011) 60cases**		**Our study (2015) 30cases**	
Results	**Non operative method**	**Plating**	**Elastic nailing**	**Non operative method**	**Elastic Nailing**	**Non operative method**	**Plating**	**Non operative method**	**Elastic Nailing**	**Non operative method**	**Elastic Nailing**	**Plating**	**Elastic Nailing**
Nonunion	5.9%	2.5%	1.6%	24%	Nil	7	2	3	Nil	3	Nil	Nil	Nil
Malunion	-	-	-	-	-	9	Nil	2	Nil	2	Nil	Nil	Nil
Infection	-	2.4%	-	Nil	Nil	-	-	Nil	Nil	Nil	Nil	2	Nil
Nail migration	-	-	-	-	-	-	-	-	-	-	5	-	1

Our Study Statistics

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mobilization Started in days	Equal variances assumed	1.181	.286	5.622	28	.000	10.333	1.838	6.568	14.098
	Equal variances not assumed			5.622	20.682	.000	10.333	1.838	6.507	14.159
Clinical union in weeks	Equal variances assumed	.103	.751	3.917	28	.001	2.333	.596	1.113	3.554
	Equal variances not assumed			3.917	27.944	.001	2.333	.596	1.113	3.554
Radio. Union in weeks	Equal variances assumed	.795	.380	3.223	28	.003	2.600	.807	.948	4.252
	Equal variances not assumed			3.223	27.563	.003	2.600	.807	.946	4.254

Test Statistics[b]

	Mobilization Started in days	Clinical union in weeks	Radio. Union in weeks
Mann-Whitney U	26.000	32.000	32.000
Wilcoxon W	146.000	152.000	152.000
Z	-3.708	-3.433	-3.426
Asymp. Sig. (2-tailed)	.000	.001	.001
Exact Sig. [2*(1-tailed Sig.)]	.000[a]	.000[a]	.000[a]

a. Not corrected for ties.

b. Grouping Variable: Group

Our study shows good functional outcome for Elastic Nailing when compared to Plating with significant value of (P<0.05).

Conclusion

Even though increased popularity of surgical methods most of the clavicle fractures managed by conservative methods till now. Nonsurgical methods are nowadays used in elderly patients with less physiological demand. But increasing evidence of good functional outcome of surgical methods favors fixation for young individuals and elderly patients with physiological demand. Good anatomical reduction for comminuted fractures and no need for implant exit are merits of plating. But surgical scar and chances of infection are more in plating. Intramedullary fixation, minimally invasive and early mobilization are the merits of elastic nailing. But need for implant exit and inadequate fixation for comminuted fractures are demerits of nailing.

In conclusion titanium elastic nail size of 2 – 2.5mm diameter is recommended for displaced midshaft clavicle fractures. When compared to plating nailing has excellent functional outcome and minimal complications.

Reference

1. Canadian Orthopedic Trauma Society. Non operative treatment compared with plate fixation of displaced midshaft clavicular fractures. A multicenter randomized clinical trial. J Bone Joint surgery Am. 2007; 89(1):1-10.doi:10.2106/JBJS.F.00020
2. Mckee MD, Pedersen EM, Jones C, Stephen DJ, Kreder HJ, Schemitsch EH *et al*. Deficits following nonoperative treatment of displaced midshaft clavicular fractures. J Bone Joint Surg Am. 2006; 88:35-40. Doi:10.2106/JBJS.D.02795
3. Robinson CM. Fractures of the clavicle in the adult. Epidemiology and classification.J Bone Joint Surg Br. 1998; 80:476-84
4. Conrad B, Wright T. Biomechanical comparison of contemporary clavicle fixation devices J Hand Surg Am. 2010; 35(4):639-44. Doi:10.1016/j.jhsa.2009.12.012
5. Assobhi JEH. Reconstruction plate versus minimal invasive retrograde titanium elastic nail fixation for displaced midclavicular fractures J Orthop Traumatol. 2011; 12(4):185-92,doi:10.1007/s10195-011-0158-7
6. Smith S, Wijdicks CA, Jansson KS, Boykin RE, Martetschlaeger F, de Meijer PP *et al*. Stability of mid-shaft clavicle fractures after plate fixation and intramedullary repair and after hardware removal.Knee Surg Sports Traumatol Arthrosc. 2014; 22(2):448-55.doi:10.1007/s00167-013-2411-5
7. Gummesson C, Atroshi I, Ekdahl C. The disability of arm,shoulder and hand (DASH) outcome questionnaire: longitudinal construct validity and measuring self-rated health change after surgery. BMC Musculoskelet Disord. 2003; 16(4):11
8. Neer CS II. Fractures of the distal third of the clavicle. Clin Orthop Relat Res. 1968; 58:53-50.
9. Nordqvist A, Petersson C. The incidence of fractures of the clavicle. Clin Orthop Relat Res. 1994; 80:476-484.
10. Nowak J, Holgersson M, Larsson S. Can we predict long-term sequelae after fractures of the clavicle based on initial findings: a prospective study with nine to ten years follow-up. J Shoulder Elbow Surg. 2004; 13(5):479-86. doi:10.1080/17453670510041475.
11. Craig EV. Fractures of the clavicle. In: Rockwood CA, Green DP, editors. Fractures in adults. Lippincott Williams & Wilkins, Philadelphia, 2006; 1, 6th edition. pp 1216-1217. ISBN: 0781746361.
12. Rowe CR. An atlas of anatomy and treatment of midclavicular fractures. Clin Orthop Relat Res. 1968; 58:29-42.
13. Eskola A, Vainionpaa S, Myllynen P, Patiala H, Rokkanen P. Outcome of clavicular fracture in 89 patients. Arch Orthop Trauma Surg. 1986; 105:337-8.
14. Huang JL, Toogood P, Chen MR, Wilber JH, Cooperman DR. Clavicular anatomy and the applicability of precontoured plates. J Bone Joint Surg Am. 2007; 89:2260-5. doi: 10.2106/ JBJS.G.00111
15. McKee MD, Pedersen EM, Jones C, Stephen DJ, Kreder HJ, Schemitsch EH *et al*. Deficits following nonoperative treatment of displaced midshaft clavicular fractures. J Bone Joint Surg Am 2006; 88:35-40. doi: 10.2106/JBJS.D.02795
16. Kabak S, Halici M, Tuncel M, Avsarogullari L, Karaoglu S. Treatment of mid-clavicular nonunion: comparison of dynamic compression plating and low-contact dynamic compression plating techniques. J Shoulder Elbow Surg. 2004; 13:396-403. doi: 10.1016/j. jse.2004.01.033.
17. Millett PJ, Hurt JM, Horan MP, Hawkins RJ. Complications of clavicle fractures treated with intramedullary fixation. J Shoulder Elbow Surg. 2011; 20(1):86-91. doi: 10.1016/j.jse.2010.07.009.
18. Calder JDF, Solan M, Gidwani S, Allen S, Ricketts DM. Management of paediatric clavicle fractures – is followup necessary? An audit of 346 cases. Ann R Coll Surg Engl. 2002; 84:331-3.
19. Owings-Web PA. Epiphyseal union of the anterior iliac

crest and medial clavicle in a modern multiracial sample of American males and females. Am J Phys Anthropol. 1985;68:457-466

20. Klein SM, Badman BL, Keating CJ, Devinney DS, Frankle MA, Mighell MA. Results of surgical treatment for unstable distal clavicular fractures. J Shoulder Elbow Surg. 2010; 19:1049- 1055.
doi: 10.1016/j.jse.2009.11.056.