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Evaluation of functional outcome of inter-trochanteric fractures treated with dynamic hip screw and locking compression plate

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Abstract

Dynamic Hip screw is the implant of choice for most inter-trochanteric fractures of the femur. But, its most common mode of failure is for the lag screw to cut out of the femoral head, the second is for the plate to be forced off the femur with the screws being pulled out of the osteoporotic bone. With the introduction of Locking plate osteosynthesis, in which fixed angle devices are used, which are not dependent on the holding power of screws alone, the bone-implant construct so formed is mechanically stable and fixation failure due to screw loosening in osteoporotic bone can be reduced. This study aims to evaluate DHS with a locking side-plate for fixation of inter-trochanteric fractures in elderly. Aim was to study the functional outcome of Locking Dynamic Hip Screw fixation in 30 patients admitted in MVJ Medical College and Research Hospital with trochanteric femur fractures in elderly age group. The clinical and radiological outcomes were evaluated with regular follow-up and the functional grading was done according to Modified Harris Hip Score. In our study, the mean time to radiological union was 19.73 weeks. There were two patients with superficial infection, one with screw cut-out and one with lateral cortex blowout. None of the patients in our study had varus collapse or side plate pull out. The average modified Harris hip score was calculated to be 83.73. Functionally, 26.67% had excellent, 50% had good, 16.67% had fair and 6.67% had poor results. The present study indicates that DHS with a locking side plate is a terrific treatment option for trochanteric fractures in elderly, with no major complications for fracture union. To accomplish the goal of early mobilisation and reduced failures, we need an implant which has an inherently stable construct independent of the bone quality, does minimal damage to the vascular supply of the bone and has a low complication rate. Locking DHS helps us achieve that goal.

Keywords: DHS, locking, trochanteric, elderly, osteoporosis

1. Introduction

With advancement in medical sciences the average life span of humans has risen. As the chunk of elderly patients increase, so does the falls associated with them, which leads to fractures amongst which the most common are the fractures of the proximal part of femur, over half of which are inter-trochanteric fractures. By 2040, the incidence is estimated to be doubled [1]. Majority of the trochanteric fractures occur due to direct trauma and major chunk of it due to a simple fall [2]. These fractures occurring in elderly patients carry the risk of prolonged immobility and recumbency [3].

Hence the primary goal of treatment is to restore the patient to preoperative status safely and efficiently, while minimizing the risk of medical/ surgical complications and technical failures. Trochanteric fractures associated with comminution, osteoporosis and instability often preclude the early resumption of full weight bearing. It should be remembered that osteoporotic bone has distinct morphologic characteristics that influence its biomechanical properties and therefore the choices and techniques for internal fixation should be well planned out.

The dynamic hip screw (DHS) is the standard implant used for the fixation of intertrochanteric hip fractures [4, 5].

The most common mode of failure of a DHS is cut out of the lag screw from the femoral head.

The second most common mode of failure is lift-off of the plate from the femur [6,7].

Locking compression plate has got features of both LC-DCP and locking screw as it uses screw heads that are conically threaded on the undersurface and create an angular stable plate screw device. Locking compression plate-dynamic hip screw has evolved to serve all our purposes.

Plates secured to bone with locking screws have been used with great clinical success in a number of locations around the body and have been found to produce a stronger construct than standard screws [8].

2. Materials and Methods

A prospective study was conducted at MVJ Medical College and Research Hospital, Bangalore, during the period from October 2016 to April 2018. 30 patients, of age 50 years or above, with trochanteric fractures of femur treated with Open Reduction and Internal Fixation using Dynamic Hip Screw and locking side plate were selected for the study. Patients with polytrauma, open fractures or neurovascular injury were not taken for the study.

All patients after admission were thoroughly assessed for any other injury and a comprehensive musculo-skeletal examination along with detailed history was undertaken. Primary stabilization was done. After primary stabilization of the patient, plain x-ray was done for an AP- view of the pelvis including both the hip joints and also of femur including the knee joint.

Skin traction was then applied. All necessary investigations were done for anaesthetic fitness for surgery.

The fractures were classified according to Boyd and Griffin classification.

All patients were posted for surgery only after anaesthetic clearance was obtained and echocardiography if required.

All patients were operated with the standard procedure of Dynamic hip screw with locking side plate. Pre-operatively, they were given third generation cephalosporin after test dose. Patient is positioned supine on a fracture table with a radiolucent, padded countertraction post between the patient's legs and the uninjured leg, flexed and abducted at the hip in a well leg holder. The peroneal nerve on the uninjured leg is padded in this position. The injured leg is held by a boot attached to the other leg extension of the fracture table. The adequacy of both anteroposterior and true lateral views is verified before surgical preparation.

A straight approximately 10-12 cm lateral longitudinal skin incision was made starting at the base of greater trochanter and carrying it distally. Subcutaneous tissue and vastus lateralis were cut along the line of its fibres. A pointed reduction clamp was used to maintain the reduction. In cases of unsatisfactory closed reduction, bone hooks or bone spikes were used to lever the fracture into reduction. A guide wire was then inserted with the help of 135 degree angle guide with the aim to keep it in centre-centre position in c-arm. Importance was given to keep the TAD (Tip-Apex Distance) less than 25 mm minus the magnification error. The required screw length was then measured and an exclusive DHS triple reamer was employed for the lag screw. Lag screw was the inserted crossing the fracture site and keeping in mind the required TAD. Appropriate 4-6 holed side plate was selected and it was pushed in over the screw and seated home with the impactor. The locking plate was then fixed to the femoral shaft with an appropriate number and size of 4.5 mm locking cortical screws. Complete haemostasis was achieved and negative suction drain is put and wound closed in layers.

Aseptic dressing was done.

Post-operatively, patient's vitals were monitored. Foot end elevation given overnight and drain monitored. Appropriate antibiotics were given. Analgesics were given as per patient compliance. Blood transfused depending upon the preoperative general condition and intraoperative blood loss. Quadriceps strengthening and knee movements were started from the second post-operative day. Mobilization with non-weight bearing started usually after first aseptic dressing change which usually was between 2nd to 5th day and continued depending on the fracture pattern and then partial weight bearing initiated after confirmation of beginning of healing process till fracture union. Full weight bearing was allowed after fracture union. Full stitch out was usually done on 12th to 14th post-operative day and patients were called for follow up at 3 weeks, 6 weeks, 3 months, 6 months and 1 year. On every visit, AP and lateral view X-rays were taken of the fracture site and were examined for union, lag screw position, fracture collapse and any other potential complication. Patients were advised appropriately on weight bearing and other physiotherapy. Functional score was done using modified Harris Hip Score and the results were classified into excellent (90-100), good (80-89), fair (70-79) and poor (<70).

3. Results

In our study, 30 patients were considered, all above the age of 50 years. Among these the youngest was 50 years old and the oldest 75 years old, with an average of 63.03 years. This was mainly done for the reason to see the effects of locking plate in osteoporotic bones. Males had a higher incidence (19 patients, 63.33%) compared to females (11 patients, 36.67%).

Table 1: Age Distribution

Age (In years)	Number of Cases	Percentage
50-60	13	43.33%
61-70	15	50%
71-75	2	6.67%
Total	30	

Mean age +1- SD	63.03+/- 5.98
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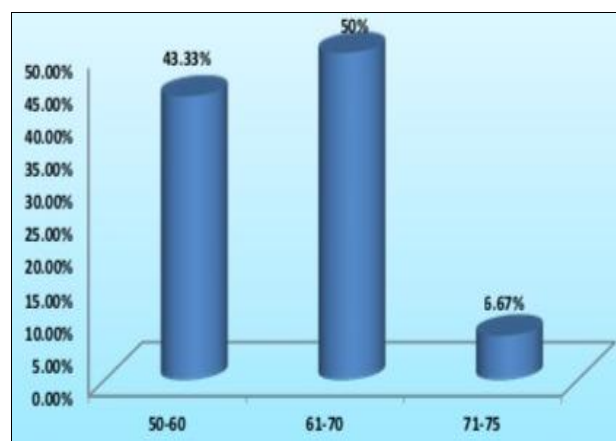


Fig 1: Age distribution

Table 2: Gender Distribution

	Number of Cases	Percentage
Male	19	63.33%
Female	11	36.67%
Total	30	

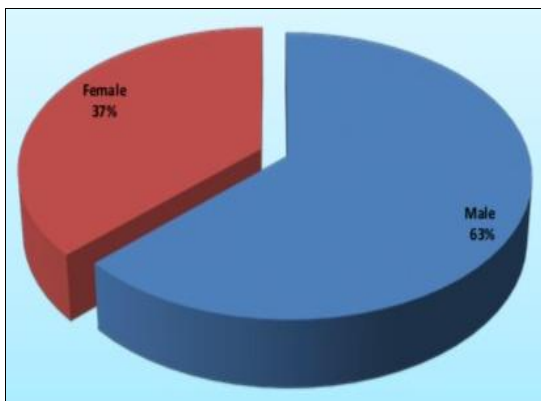


Fig 2: Sex distribution

Majority of the patients have suffered injury through fall (17 patients) i.e. 56.67% of total, rest being road traffic accidents (13 patients, 43.33%). Type of fracture depends on the mode of injury and also on patient’s age, as elderly patients have osteoporotic bones. 36.67% of the patients (11 patients) had Boyd and Griffin type 2 fracture, making it the commonest type of fracture in our study. Besides this, 7 (23.33%) patients had type 1 fracture, 7 (23.33%) had type 3 pattern and 5 (16.67%) of the patients had type 4 fracture.

Patients were taken for surgery as soon as they were hemodynamically stable and their general condition was good.

Table 3: Mechanism of Injury

	Number of Cases	Percentage
RTA	13	43.33%
TF	17	56.67%
Total	30	

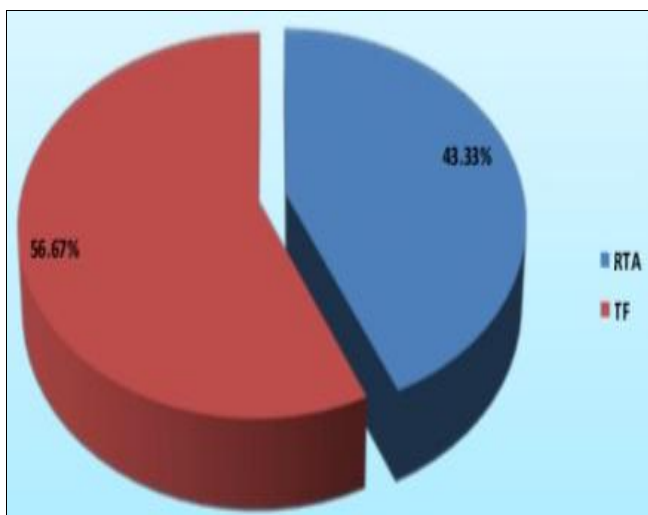


Fig 3: Mechanism of injury

Table 4: Side Affected

	Number of Cases	Percentage
Right	18	60.00%
Left	12	40.00%
Total	30	

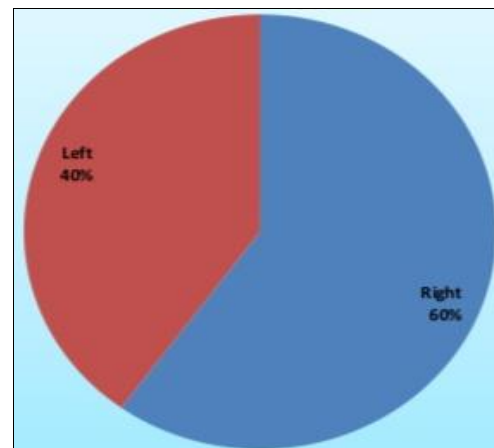


Fig 4: Side Affected

Table 5: Type of Fracture

	Number of Cases	Percentage
I	9	30%
II	14	46.67%
III	3	10%
IV	4	13.33%
I mat	30	

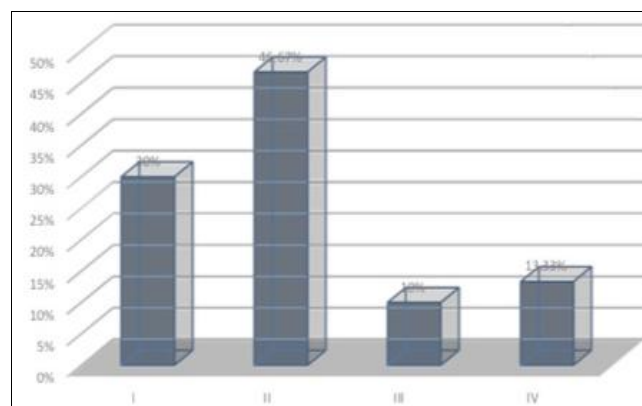


Fig 5: Type of fracture

Table 6: Associated disease

	Number of Cases	Percentage
Nil	17	56.67%
COPD	1	6.67%
DM	4	13.33%
HTH	7	23.33%
Total	30	

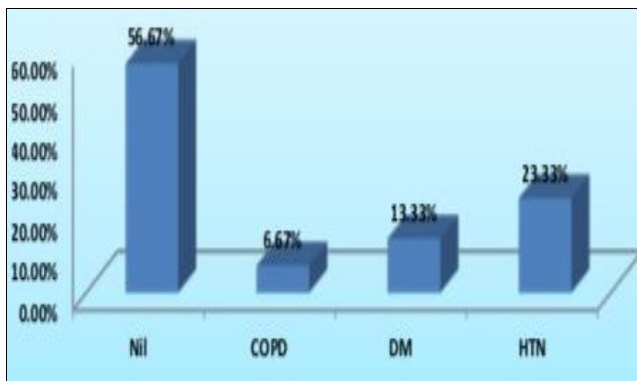


Fig 6: Associated disease

Table 7: Pre-operative HB level

Mean +/- SD	13.09 41- 1.75
Minimum Hb	9.0
Maximum Hb	153

Table 8: Complications

	Number of Cases	Percentage
Supaticial wound Infection	2	6.67%
Nil	28	93.33%
Total	30	

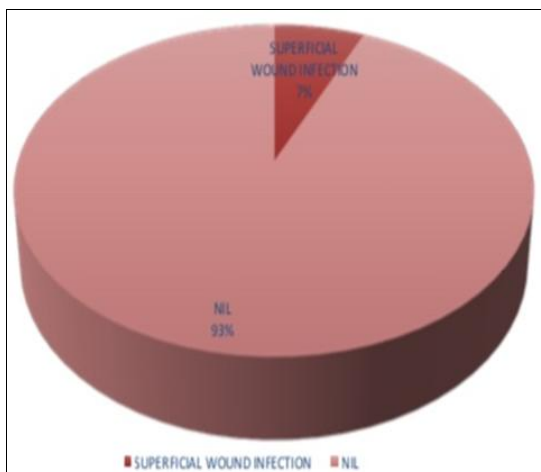


Fig 7: Complications

Table 9: Shortening (Cm)

	Number of Cases	Percentage
Nil	21	70%
1	8	26.67%
2	1	3.33%
Total	30	

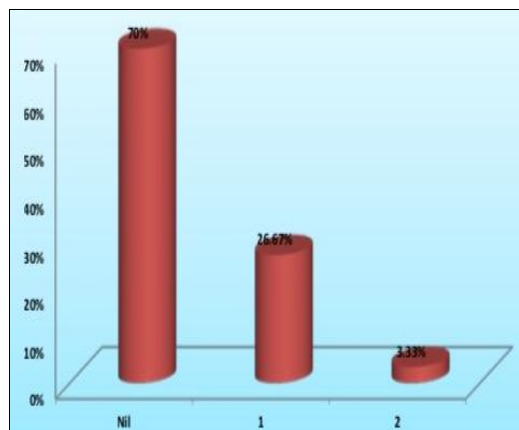


Fig 8: Shortening Analysis

Successful fracture union was defined as complete bridging callus in 3 cortices together with painless full weight bearing. Of 30 patients, 6 (20%) patients exhibited radiological union at 16 weeks, 7 (23.33%) patients between 16-18 weeks, 9 (30%) patients between 18-20 weeks, 4 (13.33%) between 20-22 weeks, 3 (10%) between 22-24 weeks and 1 (3.33%) by 30 weeks. The average radiological union time was 19.73 weeks. No patient reported nonunion.

Table 10: Time of Union (In weeks)

Union time (in weeks)	Number of Cases	Percentage
16	6	20%
18	5	16.67%
20	9	30%
22	4	13.33%
24	3	10%
28	2	6.67%
30	1	3.33%
Total	30	

Mean +/- SD	20.70 +/- 3.67 weeks
Minimum time	16 weeks
Maximum time	30 weeks

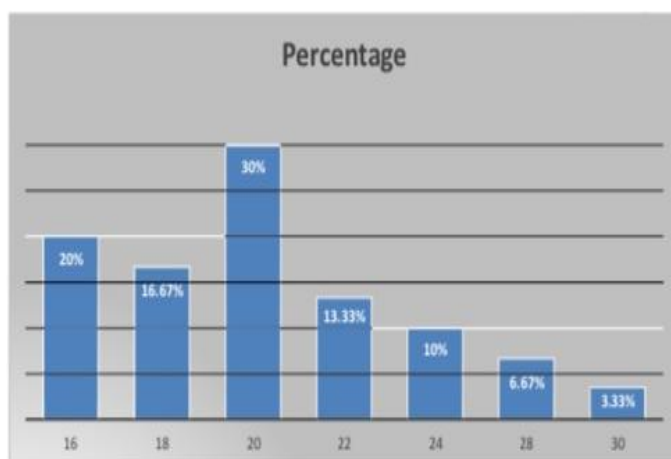


Fig 9: Time of Union

Table 11: Modified Harris Hip Score

Modified Harris Hip Score	Number of Cases	Percentage
Excellent	8	26.67%
Good	15	50%
Fair	7	23.33%
Poor	0	
Total	30	

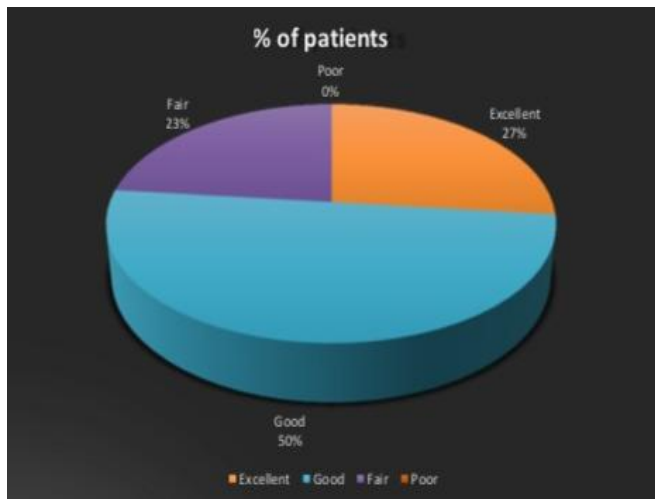


Fig 10: Harris Hip Score

Table 12: Duration of Union (In Weeks) and Fracture Type:

Fracture type	Average duration of union (in wks.)
I	20.44
II	19.14
III	22.67
IV	23

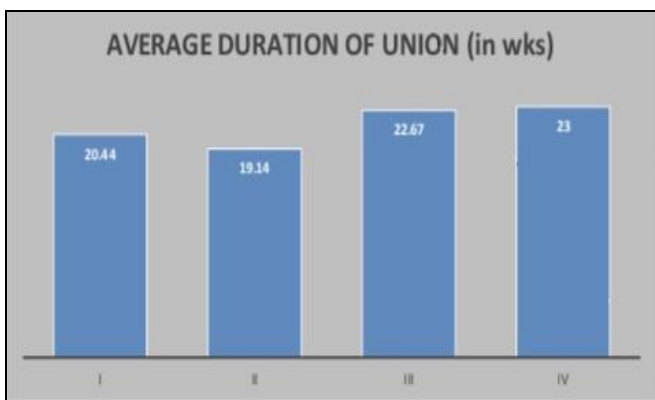


Fig 11: Duration of Union

In our study, the average union time was 20.44 weeks in type I, 19.14 weeks in type II, 22.67 weeks in type III and 23 weeks in type IV fractures.

Table 13: Age and type of fracture

Fracture type	Average age (in yrs.)
I	62.67
II	64.35
III	58.67
IV	61.25

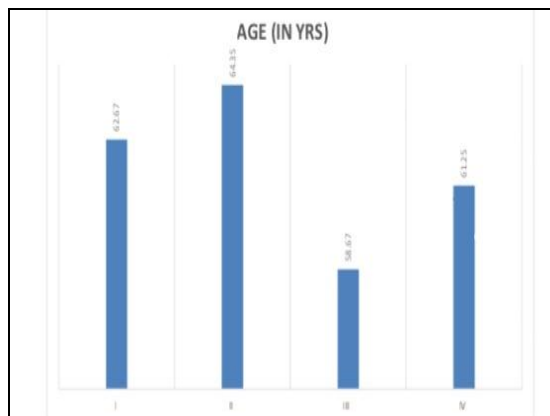


Fig 12: Age & Type of fracture

Our patients were assessed functionally with modified Harris hip score after fracture union. The average Modified Harris Hip Score in the study was 83.73. The complications came across were not very severe in nature. 2 (6.67%) of the patients had superficial wound infections, which responded to antibiotics alone. 1 (3.33%) had a lateral cortex blowout. 1 (3.33%) had lag-screw cut-out, which required revision surgery. The fracture eventually united.

Table 14: Type of fracture and mechanism of injury

Fracture hve	RTA	TF
I	4	5
II	6	8
III	2	1
I V	1	3

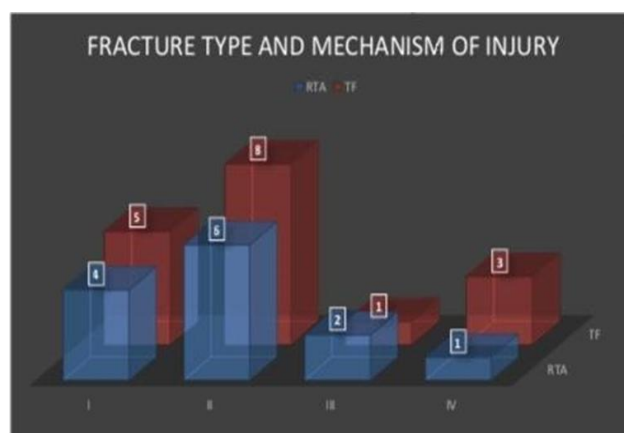


Fig 13: Type of fracture & Mechanism of injury

Table 15: Age and union time (In Weeks)

Age Group (it yrs.)	Average duration of union (in wits.)
50-60	16.76
61-70	20.33
>70	23

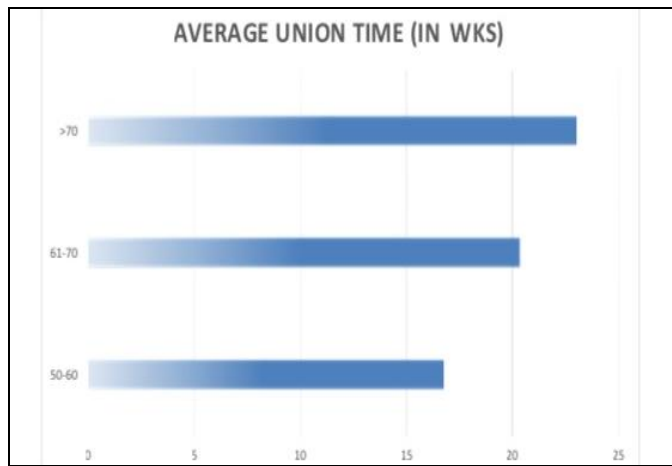


Fig 14: Age and Union Time

There was no varus collapse or side-plate pull-out. Limb-length shortening was observed in 9 patients with 8 patients (26.67%) have 1 cm and 1 (3.33%) have 2 cms of shortening.

4. Discussion

In our study, 30 patients with trochanteric fractures of femur above the age group of 50 years were considered. The best treatment for trochanteric fractures is debatable, especially for unstable types. The aim of our study was to achieve union at the fracture site and lower the usual complications associated with its fixation. The objective of our treatment is early mobilization and weight bearing so that they can regain their pre-injury functional status. This can be achieved only if the failure rates reduce in unstable fractures and osteoporotic bones of which the elderly are already prone to.

Table 16: Comparison of Age

Study	Age Range (in yrs.)	Mean Age (in yrs.)
Chatterjee <i>et al.</i>	28-84	62.45
Bannister <i>et al.</i>	65-101	80
Nikhil <i>et al.</i>	52-84	65.76
Vijay Natarajan <i>et al.</i>	22-86	58.1
Siddhartha Gangadharan	70-105	80
Present Study	50-75	63.03

Table 17: Comparison of Sex

Study	No. of males	No. of females
Chatterjee <i>et al.</i>	24	20
Bannister <i>et al.</i>	28	127
Nikhil <i>et al.</i>	11	14
Vijay Natarajan <i>et al.</i>	28	12
Siddhartha Gangadharan	27	49
Present Study	19	11

Table 18: Comparison of mode of Injury

Study	Rta	TF	FFH	Assault
Nilchil <i>et al.</i>	4	19	-	2
Vijay Natarajan <i>et al.</i>	25	10	5	-
Present Study	13	17	-	-

Table 19: Comparison of Union

Study	Average duration of union (In Irks.)
Chatterjee <i>et al.</i>	15.75
Nichil <i>et al.</i>	13.96
Siddhartha Gangadharan	10
Present Study	20.70

To accomplish such a goal we need an implant which has an inherently stable construct independent of the bone quality and does minimal damage to the vascular supply of the bone and has a low complication rate. Multiple studies have concentrated upon the position of lag screw but the side-plate has been given very little importance. Locking DHS might help us realize that goal.

Table 20: Comparison of functional results

Study	Excellent	Good	Fair	Poor
Chatterjee <i>et al.</i>	24(63.15%)	8(21.05%)	2 (5.26%)	(10.52%)
Nichil <i>et al.</i>	4(16%)	12(48%)	8(32%)	1(4%)
Vijay Natarajan <i>et al.</i>	11(27.5%)	18(45%)	8(20%)	3(7.5%)
Present Study	8(26.67%)	15(50%)	7(23.33%)	0(0%)

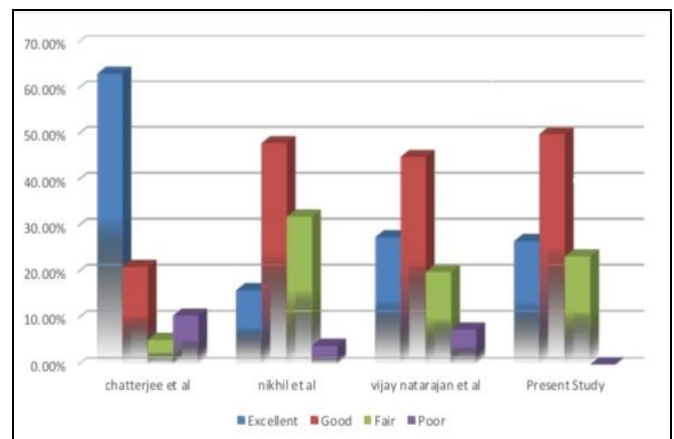


Fig 15: Comparison of functional results

Table 21: Comparison of radiological union

Study	Good	Fair	Poor
Bolhofner, Brett R	73%	17%	9%
Babst, Nikolaus	77%	13%	8.30%
Malcom, Ecker <i>et al.</i>	90%	-	9.40%
Present Study	76.67%	23.33%	0%

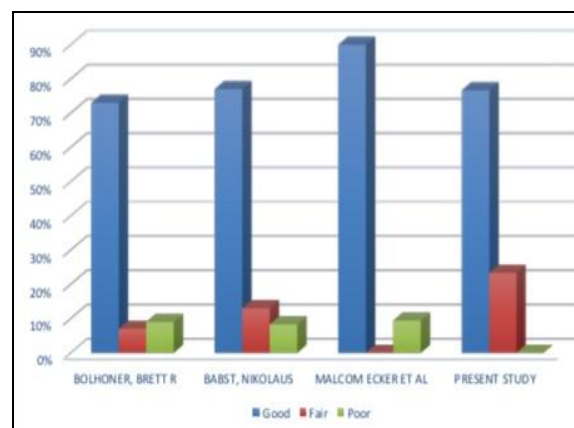


Fig 16: Comparison of radiological union

From a mechanical perspective, decreased bone density and decreased cortical thickness diminish the holding power of screws and lead to fatigue failure of the bone, resorption of the damaged bone, and ultimately to loosening of the implant. There is substantiating evidence of implant failure like lifting off of side-plate, pulling out of screws, screw toggling, screw breakage and cut-out failure of lag screw predominantly occur in osteoporotic bones with less stable fracture configurations [9]. This failure precludes early weight bearing and its related complications.

Table 22: Comparison of complication

Study	Superficial Infection	Deep Infection	Screw Cut-Out
Chatterjee <i>et al.</i>	4		3
Bannister <i>et al.</i>	3	I	II
Nikhil <i>et al.</i>	3	-	-
Vijay Natarajan <i>et al.</i>	I	-	2
Present Study	2	-	-

With the introduction of Locking plate osteosynthesis, in which fixed angle devices are used, which are not dependent on the holding power of screws alone, the bone-implant construct so formed is mechanically stable and fixation failure due to screw loosening in osteoporotic bone can be reduced [10-12].

A dynamic hip screw with locking screws would reduce the risk of DHS failure. Locking screw-DHS construct would be particularly useful in patients with poor quality, osteoporotic bone, and in patients with less stable fracture configurations. The holding power of screws in cortical bone is correlated in a linear fashion to the bone mass which reduces in osteoporotic bones [13].

It has already been proven that biomechanically locking DHS is a more suitable implant than conventional DHS with a significantly higher cut-out resistance, especially in elderly patients with osteoporotic bones [13]. Locking plates have biological advantages over the standard plates [14]. In osteoporotic bone, normal screws in DHS blade provide less anchorage compared to locking screws. A standard plate grips the bone by the friction created by the compression of the plate against the bone by the screws. This leads to impaired blood supply resulting in decreased cortical thickness and cancellous transformation of the bone. Locking plates do not

compress the bone or periosteum, so this weakening should not occur. The risk of peri-implant fractures should therefore be reduced. In a good bone, self-drilling, self-tapping cortical screws would reduce the length of the operation making it safer for the patient. Alternatively, shorter locking plates could be used, providing equivalent strength and requiring less dissection.

In our study, there has been no case of varus collapse or side plate pull out. These are the specific complications seen in a case of intertrochanteric fracture when usually fixed with a conventional DHS with a non-locking side plate, especially more prone in the osteoporotic bones of the elderly. Our results are superior to the non-locking DHS studies done by Babst and Nikolaus *et al.* [15].

However, locking side plates have a significantly higher pull out resistance as the locking plates do not depend on the screw-bone interface for stability, rather their stability is at the angular stable screw-plate interface and thus acts as a stable mono-construct as a locked internal fixator.

Also, it should be re-emphasized that TAD and neck shaft angle restoration are equally important. These are essential no matter what kind of implant is used. Optimum placement of lag screw: checked in both planes and keeping the TAD <25 mm is crucial to prevent any lag-screw migration and attaining a controlled collapse.

Moreover, factors like age of the patient, quality of the bone, nutritional status, compliance to non-weight bearing and mobilization advice particularly in less stable configurations are also important for ultimate fracture outcome. However, locking side plate has definitely minimized the implant related complications like lag screw cut-out, side plate pull out, screw breakage or any bio-mechanical failure. In fact the implant related complications are nil. Thus, with excellent union rates, patients can be mobilized early and reduce the recumbency related complications, particularly in old age.

5. Conclusion

In conclusion, the present study has shown us that locking DHS is a superior option in treating trochanteric fractures in the elderly. It gives us healthy bone healing and reduced complication rates, which is essential for a successful outcome and functional outlook for the elderly suffering from such fractures.



a)



Pre-operative X-rays.

b)

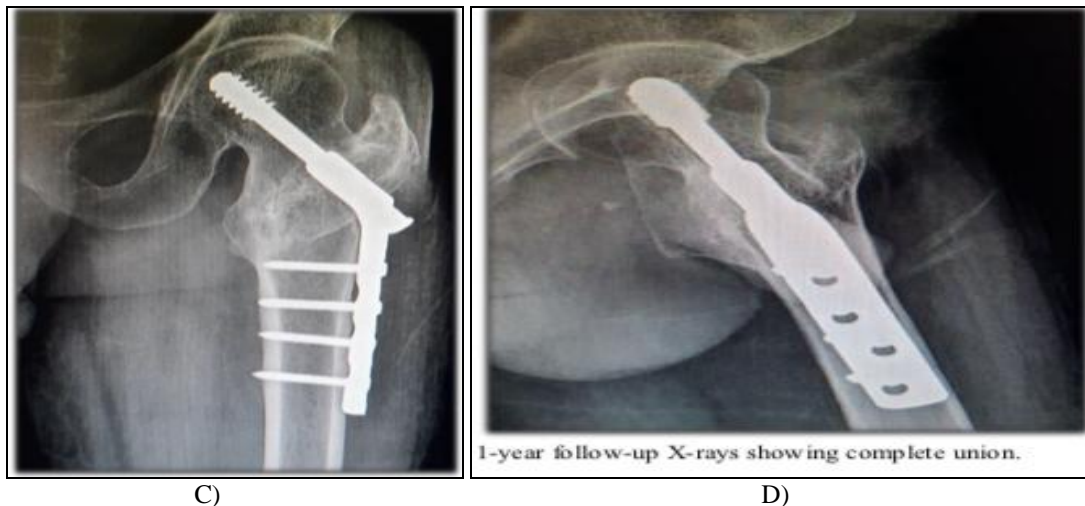


Fig 17: a) & b) PRE-Op AP & LAT View X-Ray C) & D) Post-Op X-Ray of 1 year follow up



Fig 18: Immediate Pre-Op & Post-Op X-Ray

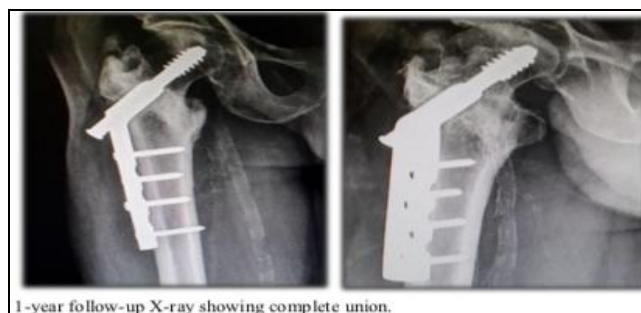


Fig 19: 3 Months & 1 year follow-up X-Rays

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