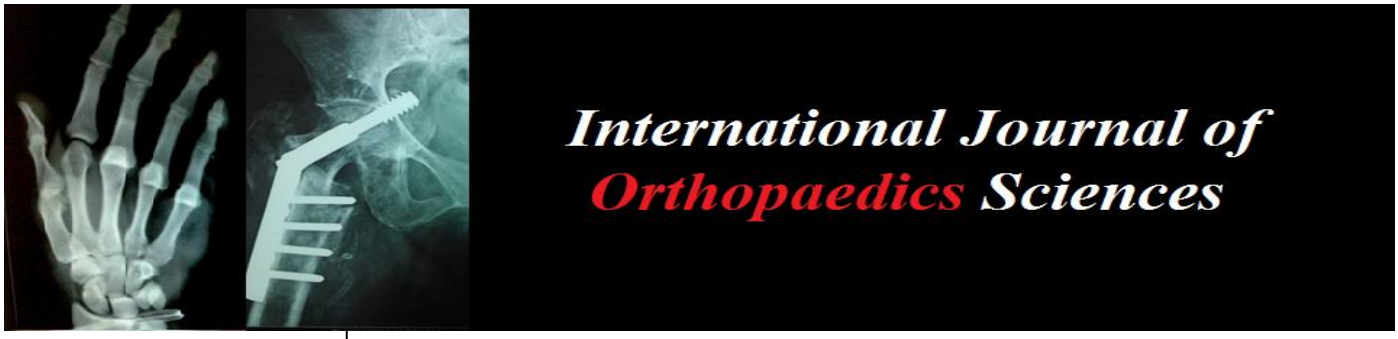

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Outcome analysis of subtrochanteric fractures fixed with dynamic condylar screw, dynamic hip screw and reconstruction nail

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Abstract
To determine the rate of union, complications, operative risks and Functional outcome in subtrochanteric fractures treated with DCS, DHS and Reconstruction Nail. To create an algorithm for surgery of choice in various Subtrochanteric fracture patterns. To determine the complications involved in the management of Subtrochanteric fractures.

Keywords: Condylar screw, hip screw, reconstruction nail

Introduction
Subtrochanteric fractures of the femur account for 10–34% of all hip fractures [1]. These fractures are known to be difficult to treat successfully [2]. Certain anatomic, biologic and biomechanical features make this area a unique proposition for the treating surgeon.
The subtrochanteric region of the femur is mainly cortical due to which the area of healing as well as the vascularity is poorer, prolonging the healing time. The forces in this area are up to 1,200 pounds/square inch on the medial cortex leading to immense stresses in the area. The strong muscles on either side of the fracture causes shear at the fracture site [3].
The goal of operative treatment is restoration of normal length and angulation to restore adequate tension to the abductors [5].
This study was based on the results of a retrospective study conducted in our hospital on a consecutive group of 28 patients presenting with subtrochanteric fractures to the casualty department. All 28 fractures were fixed with DCS/DHS or Reconstruction NAIL. The idea of the study is to determine the choice of implant in different subtrochanteric fractures.

Aims & Objectives
1. To determine the rate of union, complications, operative risks and Functional outcome in subtrochanteric fractures treated with DCS, DHS and Reconstruction NAIL.
2. To create an algorithm for surgery of choice in various
3. Subtrochanteric fracture patterns.
4. To determine the complications involved in the management of Subtrochanteric fractures.

Materials & Methods
The present study consists of 28 adult patients with subtrochanteric fractures of the femur who were treated surgically in Melmaruvathuradhiparasakthi Institute of medical college science hospital and Research Institute from Feb 2018- Feb 2019
The fractures were classified according to Seinsheimer's classification and the cases were followed up at regular intervals postoperatively. This study was conducted with due emphasis for clinical observation and radiological evaluation after surgical management of subtrochanteric fractures fixed with DCS, DHS, Reconstruction nail.

Inclusion Criteria
1. Subtrochanteric fractures in adults

Exclusion Criteria
1. Pediatric subtrochanteric fractures
2. Patients having segmental fractures of the same bone.
3. Pathological fractures
4. Old neglected fractures, fractures with implant failures and compound fractures since the functional outcome cannot be compared to that of fresh closed subtrochanteric fractures

Management of Patient

As soon as the patient with suspected subtrochanteric fracture was seen, clinical and radiological evaluation was done and admitted to ward after resuscitation and splintage with skeletal traction.

Patient is worked up for surgery with necessary blood and radiological investigations.

All the patients were evaluated for associated medical problems and were referred to respective department and treated accordingly.

Associated injuries were evaluated and treated simultaneously. The patients were operated on elective basis after overcoming the avoidable anaesthetic risks.

Pre-Operative Planning

The choice of implant for each case is based on:
1. The type of subtrochanteric fracture is classified by Scheinsheimer classification.
2. Achievement of closed reduction.
3. Surgeon's skills and familiarity with the procedure.

In type I, II, III – Intramedullary fixation was adopted if closed reduction of the fracture is achieved. If closed reduction was not achieved on traction table indirect reduction and biological DCS fixation is done.

In type IV, V –Biological DCS fixation is done.

Primary bone grafting was done in all type IV and type V cases where there is devitalization at the fracture site during the surgical procedure when open reduction of the fracture is done.

Operative Technique: Biological DCS Fixation

Table 1.

S. No	Implant used	Pain	Flexion loss	Varus, Valgus, Rotatory deformity	Limb length discrepancy	Perfect joint congruency	Results

Excellent	Flexion loss of less than 10 degrees
	No varus, valgus or rotatory deformity
	No pain
	Perfect joint congruity
Good	Not more than one of the following
	Loss of length not more than 1–2 cm
	Less than 10 degrees varus or valgus deformity
	Flexion loss not more than 20 degrees
	Minimal pain
Fair	Any of the two criteria in the good category
Failure	Flexion less than 90 degrees
	Varus or valgus exceeding 15 degrees
	Joint incongruency
	Disabling pain

X ray pelvis was taken in the regular follow up visits to assess fracture union and implant bone interaction Radiological union was said to be achieved on the evidence of obliteration of fracture lines and trabecular continuity between the two fragments on anteroposterior and lateral x rays in three cortices.

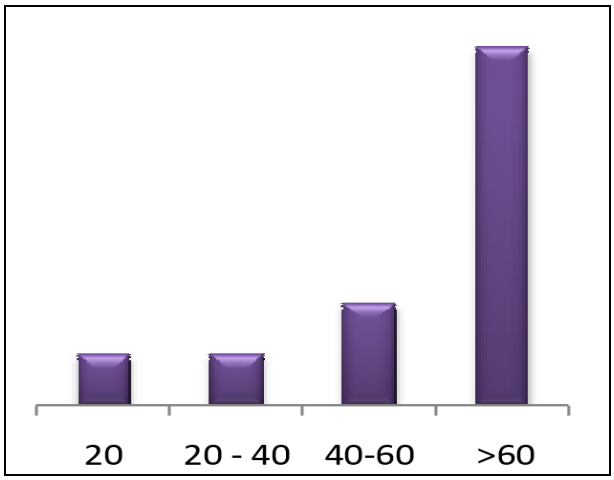
Observation and Results

The following observations were made from the data collected during the study in Melmaruvathuradhiparasakthi Institute of medical college science hospital and Research Institute from Feb 2018- Feb 2019

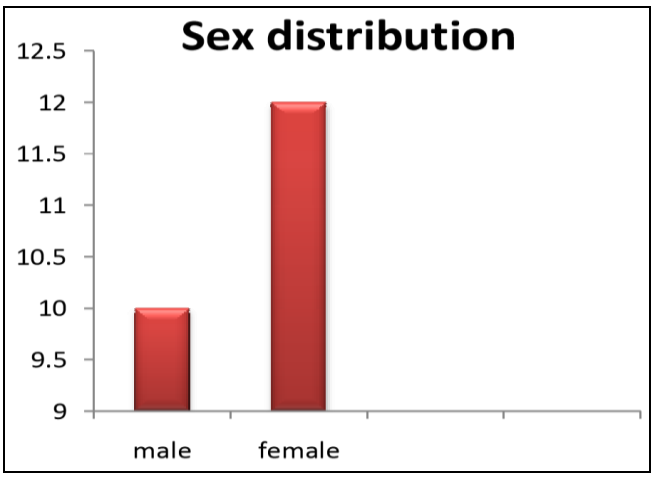
Total of 31 cases of subtrochanteric fractures are treated in the department of Orthopaedics, Three patients were diagnosed to have pathological fractures as a result of secondaries and were excluded from the study. 15 patients were treated with DCS, 8 patients were treated with DHS and 5 patients with reconstruction nail. Primary bone grafting was done in 4 patients and secondary bone grafting in 1 patient for delayed union.

Age & Sex Distribution

Incidence of subtrochanteric fractures was found to be more common in elderly females especially in >60 years age group pts with a mean age of 60.67 years



Graph 1: Age Distribution



Graph 2: Sex Distribution

Mode of Injury
Majority of the fractures were secondary to a low velocity injury.

Table 2: Mode of Injury

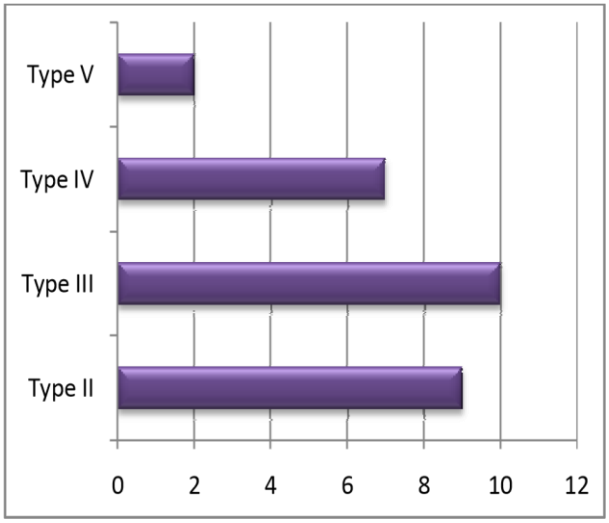
Mode of injury	No of cases
High velocity	6
Low velocity	22

Associated Injuries
In 4 patients subtrochanteric fracture was a part of polytrauma having other injuries elsewhere in the body and in one patient secondary to a trivial fall.

Classification
The 28 fractures in our study were classified according to Seinsheimer's classification. In our study we had 9 cases of type II, 10 cases of type III, &7 cases of type IV and 2 cases of type V as per Seinsheimer classification

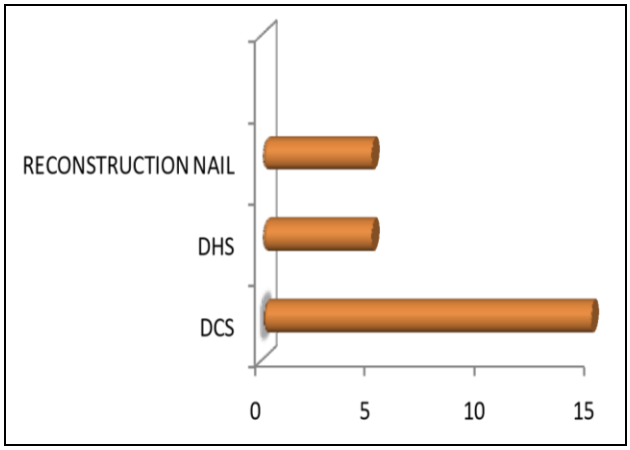
Table 3: Classification of Subtrochanteric fractures

Seinsheimer's type	No of cases
Type II	9
Type III	10
Type IV	7
Type V	2



Graph 3: Classification of Fractures

Mode of Fixation: In 8 of 28 cases, DHS fixation was done, in 15 cases DCS fixation was done and Reconstruction nailing was done in 5 cases. The choice of implant was done based on the type of fracture and ability to achieve closed reduction on the fracture table. DHS was the choice of implant for extramedullary fixation in the initial study period. Since the proximal fragment fixation is inadequate and DHS could not be done in a biological manner, DCS became the choice of implant for extramedullary fixation subsequently. In 8 of 28 cases, DHS fixation was done, in 15 cases DCS fixation was done and Reconstruction nailing was done in 5 cases. The choice of implant was done based on the type of fracture and ability to achieve closed reduction on the fracture table.
DHS was the choice of implant for extramedullary fixation in the initial study period. Since the proximal fragment fixation is inadequate and DHS could not be done in a biological manner, DCS became the choice of implant for extramedullary fixation subsequently.



Graph 4: Mode of Fixation

Table 4: Mode of Fixation

Mode of fixation	No of cases
DCS	15
DHS	8
Reconstruction nail	5

Intraoperative Details
All the patients' intraoperative details were noted in terms of duration of surgery, complications and amount of blood loss. Duration of the surgery was longer in the fractures fixed with reconstruction nail than those fixed with DCS and DHS.

Intra Operative Observations
In 2 of the 5 cases where reconstruction nailing was performed, there was a difficulty in inserting the antirotation screw as it could not be accommodated in the neck.
In case 1 of the study, antirotation screw was not inserted as it was penetrating the superior cortex of the neck and in case 24 a shorter antirotation screw was inserted.
In 2 cases [6, 17] reconstruction nailing was planned pre operatively. Since closed reduction was not able to be achieved biological DCS fixation was chosen.
In 2 cases [8, 20], biological DCS fixation was planned. Since proper reduction was not achieved, open reduction of the fracture was done.

Post-Operative Complications
Open DCS fixation: Implant failure secondary to delayed union – 1

Biological DCS fixation: Wound infection - 1, Unicortical break in the neck of femur- 1, Delayed union - 1
DHS fixation: Wound infection - 1
Reconstruction nail fixation: Wound infection - 1, Delayed union- 1

Condition at discharge
All the patients were mobilized non weight bearing using walker. However in 4 patients mobilisation was delayed due to associated injuries.

Mortality
One patient (Case 19) died due to acute coronary syndrome one month post operatively which was not related to the surgical event.

Follow up
All patients were followed up at 4 weeks, 12 weeks and every

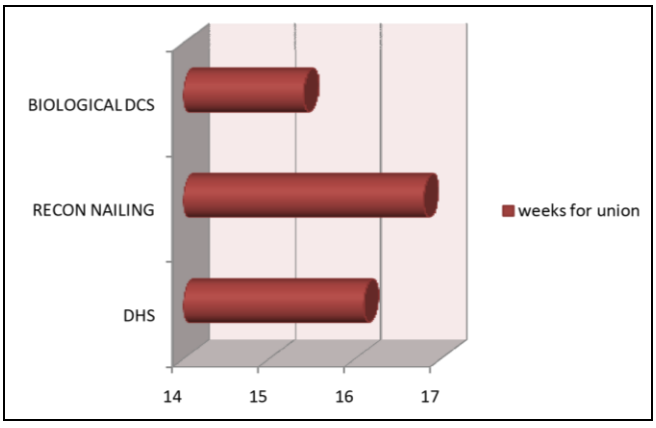
6 weeks thereafter till fracture union is noted and at 6 months. Two patients (Case 14, 22) failed to attend the first follow up and were lost for further follow up and one patient (Case 19) expired one month post operatively due to acute coronary syndrome. One patient (Case 8) had implant failure secondary to delayed union. One patient (case 24) patient had hip pain in the post-operative period due to fracture site instability as the proximal fragment was inadequately fixed with the cephalomedullary screws. One patient (case 16) developed hip pain in the immediate post-operative period and was diagnosed to have Unicortical break in the neck of femur which went on to unite without any intervention and the mobilisation was delayed in view of unicortical break in the neck of femur.

Table 5: Clinical Outcome Using Radford *et al* Criteria: [38]

Case no	Implant used	Pain	Flexion loss	Varus/Valgus/ Rot deformity	L.L discrepancy	Joint congruency	Results
1	Recon nail	A	A	A	A	P	Excellent
2	DHS	A	A	A	1 cm	P	Good
3	Biological DCS	A	A	A	A	P	Excellent
4	Biological DCS	A	A	10 deg	2cm	P	Fair
5	Recon nail	A	A	A	A	P	Excellent
6	Biological DCS	A	A	A	A	P	Excellent
7	DHS	Minimal pain	A	A	A	P	Good
8	DCS	Disabling pain	Painful restriction	A	2cm	P	Failure
9	DHS	Minimal pain	A	10 deg	A	P	Fair
10	Biological DCS	A	A	20 deg	A	P	Good
11	Biological DCS	A	A	A	A	P	Excellent
12	DHS with bone grafting	A	A	30 deg	1cm	P	Fair
13	Biological DCS	A	A	A	A	P	Excellent
14	Biological DCS	A	A	A	A	P	LIF
15	Biological DCS	A	A	A	A	P	Excellent
16	Biological DCS with bone grafting	Minimal pain	30 deg	20 deg	1cm	P	Failure
17	Biological DCS	A	A	A	A	P	Excellent
18	Biological DCS	Minimal pain	30 deg	A	A	P	Fair
19	DHS with bone grafting	A	A	A	A	P	LIF
20	DCS	A	20 deg	A	A	P	Good
21	Biological DCS	A	A	A	A	P	Excellent
22	DHS locking plate with bone grafting	A	A	A	A	P	LIF
23	DHS	A	30 deg	10 deg	A	P	Fair
24	recon nailing	Minimal pain	20 deg	A	A	P	Fair
25	DHS	Minimal pain	A	A	A	P	Good
26	Recon nail	Minimal pain	A	A	A	P	Good
27	Biological DCS	A	A	A	A	P	Excellent
28	Recon nail	Minimal pain	A	A	1cm	P	Fair

Union in Weeks

Biological DCS fixation- 15.4 weeks (10-32 weeks) DHS fixation- 16.1 weeks (14-20 weeks) Reconstruction nail fixation- 16.8 weeks (12-30 weeks) One patient (Case 28) in reconstruction nail fixation group went for delayed union (30 weeks).By eliminating this case from the group there is a significant improvement in the standard deviation (7.56 to 1.91) and the average time for union in the remaining cases is 13.5 weeks. One patient (Case 27) in the DCS fixation group went for delayed union (32 weeks). By eliminating this case from the group the average time for union in the remaining patients is 15 weeks.



Graph 5: Union in Weeks

Discussion

Subtrochanteric fractures of the femur demand a special consideration in orthopedic traumatology, given the high rate of complications associated with their management due to the high loading forces and immense stresses in this area.

Even though better reduction techniques and biomechanically improved implants and improved fracture fixation techniques have improved the functional outcome of these fractures ideal implant for these fractures is still not defined. No single implant is ideal for all types of subtrochanteric fractures. An ideal implant should achieve stable fixation with no interference with the vascularity and hold the fracture till it unites. Fixation is a race between fracture healing and implant failure. Irrespective of the mode of fixation emphasis is laid on the medial cortex reconstitution as described in the study by Senter B *et al.* [56] but in many of these fractures, reconstruction of solid medial wall is not possible, due to comminution or bone loss where autogenous bone grafting is suggested. This study analyses various aspects needed to be addressed while treating subtrochanteric fractures and determine the choice of implant in different subtrochanteric fractures.

Reconstruction Nail Fixation

Intramedullary devices require less surgical exposure, enable early weight bearing and exert less biomechanical stresses (as the lever arm is moved medially) [39-41] However technical difficulties are observed in upto 63% of the cases. [42, 43] Lavell

David G *et al* described Reconstruction nailing as a technically demanding procedure and suggested plate and screw fixation as the best option [1].

We had difficulty in putting the derotation screw in 2 out of 5 cases (40%) compared to that of a study by Fogagnolo *et al* where 23.4% of intraoperative technical and mechanical complications were noted. When intramedullary devices cannot be used for technical reasons dynamic condylar screw provides a reasonable option.

In 2 cases where we had planned intramedullary nailing, procedure was abandoned as we were unable to achieve a perfect closed reduction and hence converted to DCS fixation.

Average time for union was 16.8 weeks compared to 15.1 weeks in a study by Lee *et al*. [44] with 60% excellent to good functional outcome. We had achieved 100% union rate with one case of delayed union simulating the results of a study by Gibson *et al*. [45].

Reconstruction Nail is Recommended In

- Type I, II & III subtrochanteric fractures when closed reduction is achieved.

Recon nail is not preferred in severe communited fractures and fractures with trochanteric extension as we feel that the hold of the implant on the proximal fragment is not adequate and also it is an observation that the head screws do not lock onto the nail and hence compromising the stability of the fixation. Recon nail is not preferred in severe communited fractures and fractures with trochanteric extension as we feel that the hold of the implant on the proximal fragment is not adequate and also it is an observation that the head screws do not lock onto the nail and hence compromising the stability of the fixation.

DHS Fixation

Some decades ago, a sliding-screw plate system came into wider use even in subtrochanteric fractures because of the successful treatment of stable trochanteric fractures [48]. In unstable per- and sub-trochanteric fractures, however, the system has been reported to involve high failure rates [46-48] as it may not be possible to supplement the sliding screw with additional cortical screws in the proximal fragment of a subtrochanteric fracture [50]. Biologically, extensive comminution and fragment devitalisation compromises bone healing [49] Extensive dissection at the fracture site is required to place the DHS implant. Even though we had achieved 100% union rate with average time for fracture healing of 16.1 weeks with no complications and 50% good functional outcome, the implant has its limitations of inadequate proximal fixation and it could not be done in a biological manner.

DCS Fixation

Comminuted subtrochanteric femoral fractures are often caused by high-energy trauma [51, 52]. Fractures may extend into the greater and the inter-trochanteric regions [49] Open reduction further devitalizes fragments, damages the vascular supply or soft tissues, and increases the risks of non-union, infection, and implant failure [51] whereas indirect reduction does not [49].

One case of implant failure (12.5%) is observed in fractures fixed with DCS by open reduction compared to failure rates of 20 to 23% in different studies [53, 54] The likely cause for delayed union and implant failure was not doing a primary bone grafting in an extensively communited fracture.

In one case patient was found to have a Unicortical break in the neck of femur secondary to fixation with a short head screw which united without any intervention and mobilisation was delayed in this patient.

Vaidya *et al*. [55] evaluated the use of DCS and biological reduction techniques for subtrochanteric fractures and concluded the use of indirect reduction techniques instead of anatomic open reduction has proven to be successful, especially in comminuted fractures.

DCS fixation when done biologically have shown better results compared to those fractures fixed with Reconstruction nail [44].

100% union rate is observed in cases where biological DCS fixation with 9 out of 13 patients had excellent to good results compared to the results obtained in the study by Vaidya *et al*. [55] Average time for radiological union in cases where biological fixation is done was 110 days compared to 91 days in the study by Neher *et al*.

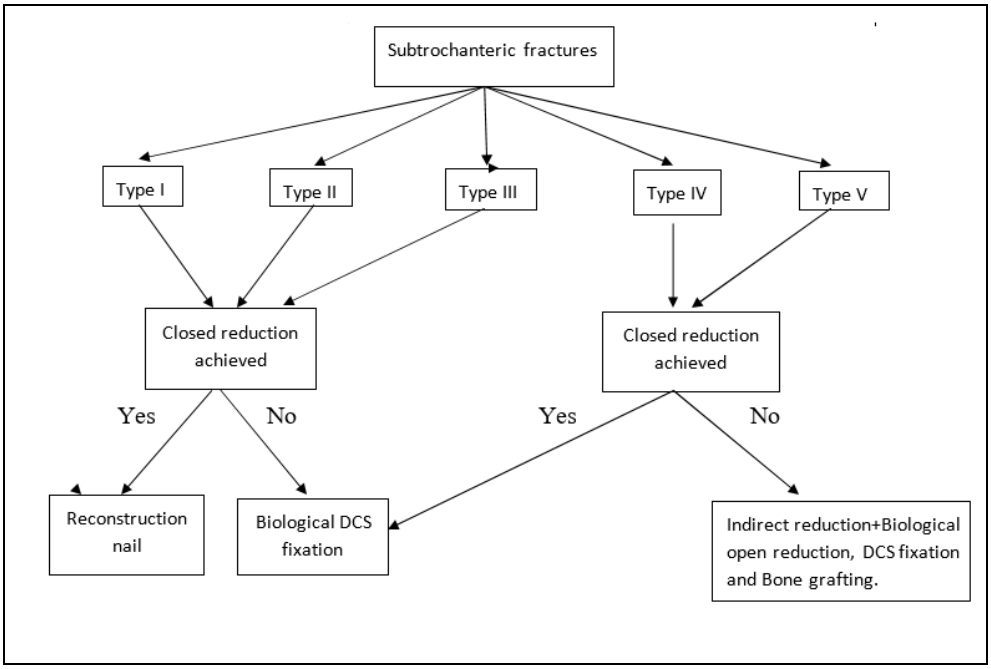
It could be a preferred implant of choice in:

- Type IV and type V subtrochanteric fractures.
- Revision surgeries.

DCS fixation should be done in a biological manner without opening the fracture site whenever reduction is achieved by indirect means to avoid the need for bone grafting and devitalisation of the fracture fragments.

In the management of subtrochanteric fractures ideal implant selection is important for a better functional outcome.

We Propose the Following Algorithm for Management of Subtrochanteric Fractures



Limitations

- Numbers are small to make a scientific comparison.
- Large no of cases are required to assess the reliability of the proposed algorithm.

Conclusion

- No single implant is ideal for all subtrochanteric fractures
- Intramedullary implant can be used in type I, II & III fractures if closed reduction is achieved.
- Biological DCS fixation is superior to other modes of fixation in type IV & V subtrochanteric fractures.
- Biological DCS fixation reduces the need for bone grafting in communited subtrochanteric fractures.
- Stable internal fixation using indirect reduction techniques rather than anatomic reduction enhances healing potential.

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