A Novel Method of Management of Unstable Trochanteric Fractures - A Retrospective Study in a Tertiary Care Hospital, Mysore

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ABSTRACT

BACKGROUND

Trochanteric fractures are commonly encountered in elderly patients, and the outcome may be bad, if not intervened early. Dynamic hip screw (DHS) fixation is the most common treatment in stable trochanteric fracture. In unstable trochanteric fractures, there is high incidence of failure in view of excessive collapse seen with dynamic hip screw. In order to limit the collapse, we have done a modification on dynamic hip screw implant. Here we have assessed fracture healing, collapse and implant failure, in unstable trochanteric fractures (Evan's unstable fractures) treated by modified dynamic hip screw fixation.

METHODS

The present retrospective case record analysis was conducted among 31 patients with unstable trochanteric fracture classified according to Evan's classification who were operated with modified DHS in a tertiary care hospital. The details about fracture healing, collapse of fracture fragments, implant failure were assessed in a structured checklist through the case record analysis.

RESULTS

Out of 31 patients in this study, 29 patients showed fracture healing (93.5 %) with or without minimal collapse and 2 patients had non-union (6.5 %) at the end of 5 months follow up. Ultimately, all fractures united at the end of 1-year follow-up. Out of 31 patients in this study, at first month follow-up, 26 patients showed no implant failure (83.9 %), 5 patient had implant migration not breaching cortex (16.1 %), at third month follow-up, out of 5 patients who had implant migration, two patients had implant migration not breaching cortex (6.4 %), 3 patients had implant migration breaching cortex (11.0 %), at fifth month follow-up, two patients had implant migration not breaching cortex (6.4 %), 3 patients who had implant migration breaching cortex underwent revision surgery (11.0 %).

CONCLUSIONS

Modified dynamic hip screw has shown improved results as compared to normal dynamic hip screw in treating unstable trochanteric fracture, which limits the collapse at fracture site.

KEYWORDS

Unstable Trochanteric Fractures, Collapse, Modified Dynamic Hip Screw

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BACKGROUND

Trochanteric fractures are commonly encountered in elderly population. Trochanteric fracture treatment remains controversial.[1-3] Trochanteric fracture accounts around 50 % of fractures of the proximal femoral region. They are the main reasons for the cause of disability leading to decreased quality of life and also leading for mortality. "S.S. Babhulkarin 2006 stated that 90 percent of intertrochanteric fractures of the femur in elderly occurs majorly due to an osteoporotic bone after a simple fall, where as in young individuals it may be due to high velocity injuries such as motor vehicle accidents or fall from height.[1] Many methods have been recommended.[4-6] Stable fixation and early mobilization was the treatment in trochanteric fractures of femur. Reinstatement of mobility for trochanteric fracture was ultimately determined by surgical construct. Arun Singh et al. in 2006 have proposed that although rigid fixation can be achieved through various fixation, the dynamic hip screw is the most commonly preferred device for intertrochanteric fracture.[3] Early mobilization of the patients decreases the complication rate.

Trochanteric fracture with comminution and displacements are mostly seen in old age patients. Most of the old age patients have very low bone quality due to which fractures are often associated with complication like non-union, implant failures and femoral head perforation. Management of unstable trochanteric fractures are challenging because of lag screw cut out, loss of fixation, excessive collapse, implant failure, and in addition osteoporosis also adds to the complication resulting in unpredictable outcome. Failures of dynamic hip screw are due to over collapse, inability to maintain posterior-medial cortex continuity, inability to maintain anatomical relationship between fragments, inability to position screw in the central zone and tip-apex distance < 25 mm.[7]

Litchblau in 2008 also added that displacement can also result in malunion, non-union and failure of fixation device.[8]

According to Watson et al. in 1998, stable trochanteric fractures are commonly treated with dynamic hip screw fixation with failure rate less than 2 %. The treatment of unstable trochanteric fractures is more controversial and has got multiple modalities of treatment with no clear-cut guidelines.[9]

In order to limit the collapse in dynamic hip screws, we have made a modification on dynamic hip screw implant. In this study we are assessing the outcome of unstable trochanteric fractures treated with modified dynamic hip screw fixation designed by us.

Evans's in 1949 presented a way simpler classification based on dividing the fractures into stable and unstable groups. He further divided the unstable into those in which stability could be restored by anatomic or near anatomic reduction and in those in which anatomic reduction would not produce stability.[10]

In stable fracture patterns, the posteromedial cortex remains intact or has minimal comminution, making it possible to obtain and maintain a reduction. Unstable fracture patterns, conversely, are characterized by greater comminution of the posteromedial cortex. The reverse obliquity pattern is inherently unstable because of the tendency for medial displacement of the femoral shaft.[10]

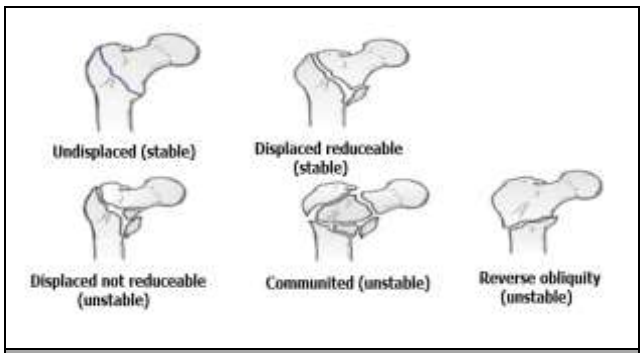

Figure 1. Classification of Stable and Unstable Fractures

Principles of Management

Low energy falls from standing height is the most common mode of injury for these fractures. These fractures are commonly seen in patients older than 50 years of age.

High energy fractures are relatively rare and if it occurs, they are common in men less than 40 years of age. Cummings in 1989 hypothesized that four conditions were correlated for fall to cause a hip fracture.

1. Patient who falls will be oriented to impact around hip.
2. All the protective responses must fail.
3. Lost soft tissues should absorb less energy than necessary to prevent fracture to occur.
4. Residual energy of fall applied to proximal segment must exceed its original strength.

This concept applies primarily for strategies in preventing hip fractures. Fall with rotational component is more commonly seen with extra-capsular fractures.

In some instances, patients also present with distal radius, proximal humerus and minor head injuries associated with low energy falls. High energy fractures are commonly associated with ipsilateral extremity trauma, pelvis fractures and head injuries.[11]

Pre-morbid diseases may also co-exist with fracture diagnosis. Syncopal attacks resulting fall should focus attention on neurological and cardiovascular disease states. Any primary neoplastic or metastatic disease may reveal preceding hip pain and subsequent fall that results in fracture.[10]

About Implant

Dynamic Hip Screw

Dynamic hip screw or Sliding screw fixation is an implant assembly consisting of a lag screw, a side plate and cortical screws which fix the side plate to the proximal femoral shaft. The lag screw is a thick screw which is inserted into the head of femur from lateral aspect of proximal femur. The side plate has angled barrel which glides over the distal part of the screw and the side plate is fixed to the proximal femur with help of cortical screws.

Dynamic hip screw is used in fixation of proximal femur fractures mainly intertrochanteric fractures, but can also be used in selected cases of fractures of femoral neck and subtrochanteric fractures.[12]

Biomechanics of Dynamic Hip Screw

To understand the principle of fixation behind dynamic hip screw, we need to go to their history of development. Earlier, angled blade plates were used to fix intertrochanteric fractures and other proximal femoral fractures. These implants were of static kind as compared to dynamic nature of sliding hip screw assembly. These angled blade plates had a fixed angle to match the neck shaft angle. One part of these plates was inserted into lateral cortex of proximal femur and passed along the neck to take final purchase into the head. The distal part was fixed to the femoral shaft by screws. Apart from other issues like failure of purchase and frequent need for osteotomies to accommodate the plate, a major concern was that these plates did not allow any compression across the fracture site as the rigid unibody assembly did not allow any movement. It led to stress failure of the implant and frequent non-unions as no compression was allowed after surgery was done. Dynamic hip screw or sliding hip screw is a unique assembly. The screw can slide in the barrel of the plate. Therefore, when the person bears weight, the screw slides and comes along and the proximal fragment compresses on to the distal fragment. Thus, idea behind the dynamic compression is that the femoral head component is allowed to move and fracture fragments come together for better healing. The side plate via its barrel provides strong support to the sliding screw and allows it to collapse in a controlled manner.[13]

About Modified Dynamic Hip Screw

One of the causes for failure of dynamic hip screw was over collapse at fracture site.[7] In this study, we have used modified dynamic hip screw to limit the over collapse which is undesired in unstable trochanteric fractures. In this implant we have done modification in the shaft of lag screw, we have reduced the length of keyed screw system, so that we can have a maximum of 1 cm collapse, hence there will be limitation in collapse unlike the original implant.

Figure 2a. Modified Lag Screw Versus Normal Lag Screw

Normally the Richardson screw is flattened throughout, in our innovative design we have modified the screw by making a wedge in the flattened area [Keyed Screw system], so as to prevent the over collapse, which cannot be achieved with normal screw design.

Figure 2b. Normal DHS Fully Collapsed vs. Modified DHS Limitation in Collapse

Technique of Modified Dynamic Hip Screw

For this surgery, a C-arm is required to check for guide wire and screw positioning. Usually the surgery is performed for intertrochanteric fractures. Most of them could be treated closed. The majority of intertrochanteric hip fracture can be reduced on a fracture table. Occasionally, however, an open reduction may be necessary to achieve adequate fracture alignment. The size of hip screw is measured preoperatively on the x-ray to get an idea about probable size to be used. The patient is supine on the fracture table with feet padded and placed firmly in fracture table boots. Contra-lateral leg is either dropped down or raised on a 90° thigh holder. There should be enough padding into groin and genitals to be protected. Ipsilateral arm is taped over the chest. After preparation of the parts, the proximal femur is exposed through an incision extending from the greater trochanter to approximately 8 - 10 cm distally. The lateral femur is exposed, and a guide wire is drilled from the lateral femur into the femoral head. The guide wire should be centred in the femoral neck in both the lateral view and the anteroposterior (AP) view. The angle between the wire and the femoral shaft must be equal to the angle of the proposed fixation device (usually 135°). The tip of the guide wire must lie in the center of the femoral head and 1 cm from the subchondral line on both the AP and lateral views. After the guide wire is confirmed to be in place, the cannulated reamer [also called as triple reamer] is used to drill over the already placed guide wire till the tip of the wire. The reamer is set to the correct depth as measured on table by direct measuring device. The lag screw is inserted into the femoral head after tapping of the drilled channel. The side plate and barrel are placed over the screw and attached to the femoral shaft with the appropriate screws. Fluoroscopic images are taken throughout the repair to ensure the maintenance of the reduced fracture position and the proper positioning of the fixation device. Depending on the bone strength, two to six holes plate is used in intertrochanteric fractures. Longer plates are required in case of subtrochanteric fractures. It is desirable to obtain compression at the fracture site. For

this, traction on the affected limb is released and compression screw is inserted. Wound is closed in layers.[14]

Objectives

1. To assess fracture collapse, healing in management of unstable trochanteric fracture with modified dynamic hip screw.
2. To look for implant loosening, implant cut-out and implants failure-migration of implant or non-union.

METHODS

The present retrospective case record analysis was undertaken in a tertiary care hospital. A total of 31 patients with unstable trochanteric fractures according to Evan's classification and operated by modified dynamic hip screw fixation between Jan 2017 to Aug 2019 were taken up for the study. Patients with stable fractures, pathological fractures, infection, treated after 3 weeks of trauma, compound fractures associated with vascular injuries, ipsilateral femoral shaft fractures and pelvic fracture were excluded. The details about fracture healing, collapse of fracture fragments, implant failure was assessed in a structured checklist through the case record analysis.

Statistical Analysis

Data collected was entered in MS Excel 2010 and analysed using SPSS version 18. 0 Descriptive statistical measures like percentage was used. Data is presented as tables.

RESULTS

Fracture Healing	1st Month	3rd Month	5th Month
Healed	10 (32.3 %)	28 (90.3 %)	29 (93.5 %)
Not healed	21 (67.7 %)	3 (9.7 %)	2 (6.5 %)
Total	**31 (100 %)**	**31 (100 %)**	**31 (100 %)**

Table 1. Distribution of Study Subjects Based on Fracture Healing after 1st, 3rd and 5th Month of Surgery

Fracture Collapse	1st Month
Minimal collapse	18 (58.1 %)
No collapse	13 (41.9 %)
Total	**31 (100 %)**

Table 2. Distribution of Study Subjects Based on Fracture Collapse after One Month of Surgery

Implant Failure	1st Month	3rd Month	5th Month
No implant failure	26 (83.9 %)	26 (82.6 %)	26 (82.6 %)
Implant migration not breaching cortex	5 (16.1 %)	2 (6.4 %)	2 (6.4 %)
Implant migration breaching cortex	0	3 (11 %)	3 (revision surgery) (11 %)
Total	**31 (100 %)**	**31 (100 %)**	**31 (100 %)**

Table 3. Distribution of Study Subjects Based on Collapse after 1st, 3rd and 5th Months of Surgery

Among 31 patients included in the study, Pre-operative AP x-rays of pelvis with hips was taken for all patients who were treated by modified dynamic hip screw fixation. All patients who underwent treatment were of age from 38 years to 90 years. Out of 31 patients in this study, 20

Figure 3a. Pre OP

Figure 3b. Post OP

Figure 3c. 5th Month

Figure 3. Radiographs

patients were males (64.5 %) and 11 patients were females (35.5 %). Only Evan classification-unstable

fractures were taken in view of standardization. Post-operatively, follow up x-ray was taken at 1st month, 3rd month and 5th month and the outcome were assessed.

Factors Assessed

1. Fracture healing.
2. Fracture collapse.
3. Implant failure.

Fracture Healing

Fracture healing was assessed by taking radiographs at first month, third month and fifth month or till complete healing. Cortical bridging noted in x-rays was considered to be fracture healing. Out of 31 patients in this study, at first month follow-up, 10 patients showed fracture healing (32.3 %), at third month follow-up, 28 patients showed fracture healing (90.3 %), at fifth month follow-up, 29 patient showed fracture healing (93.5 %) and two patients had non-union (6.4 %)

Fracture Collapse

Fracture collapse was assessed by calculating the distance between base of lag screw and slide plate. Out 31 patients in this study, at first month follow-up, 13 patients showed no collapse (41.9 %) and 18 patients showed minimal collapse (58.1 %) [Less than 1 cm], however the collapse rate remained same for all patients till end of this study.

Implant Failure

Implant failure was considered by migration of implant, implant loosening, and implant cut-out and non-union. Out of 31 patients in this study, at first month follow-up, 26 patients showed no implant failure (83.9 %), 5 patient had implant migration not breaching cortex (16.1 %), at third month follow-up, out of 5 patients who had implant migration, two patients had implant migration not breaching cortex (6.4 %), 3 patients had implant migration breaching cortex (11.0 %), at fifth month follow-up, two patients had implant migration not breaching cortex (6.4 %), 3 patients who had implant migration breaching cortex underwent revision surgery (11.0 %).

DISCUSSION

Trochanteric fracture is mainly treated by surgical interventions. Despite long term experiences in many centres, there have been factors still contributing to poor outcome of managing unstable trochanteric fracture. There is lack of proper per-operative risk factors assessment that affects the outcomes in this fracture treated by various methods. Failures of dynamic hip screw in unstable trochanteric fracture is due to over collapse at fracture site. [7]

In this study, we have used modified dynamic hip screw for treating unstable trochanteric fractures, we have used this implant to limit the over collapse at fracture site.

Fracture united in 29 patients with minimal collapse and 2 patients had no signs of union at the end of 5 months. But in all fractures that united at the follow-up period of 1 year, lag screw migration occurred in 5 patients who started early weight bearing.

Nor din S in their study on treatment of trochanteric fractures with dynamic hip screw, 83. 3 percent of patients had fracture healing at one month.[15] In our series only 32.3 percent of patients showed fracture healing at first month, however at the end of fifth month, 93.5 % fractures went on to heal. This delay in fracture healing relates to the modification in design of implant which limits the collapse at fracture site.

"Sadowskical et al. in their study, On treatment of unstable trochanteric fractures with sliding hip screw, implant failure and non-union was noted in 7 of 19 patients (38 %) who had been treated with the sliding hip screw.[16] Out of 31 patients in this study, at first month follow-up, 13 patients showed no collapse (41.9 %) and 18 patients showed minimal collapse (58.1 %) [Less than 1 cm].

However, the collapse rate remained same for all patients till the end of this study. No patient had a collapse of more than 1 cm. This is related to the design of implant whose modification allows collapse of less than 1 cm. No literature was available where amount of collapse at fracture site was discussed. In our series, implant migration was noted in 5 out of 31 patients (16.1 %). Out of these 5 patients, 3 patients had breaching of cortex and eventually went for revision surgeries. This result comparatively favours and highlights the advantage of modified dynamic hip screw in treatment of unstable trochanteric fractures.

Imaging and Other Diagnostic Modalities

Plain radiographs of AP view of pelvis, AP and cross table lateral view of the affected hip are usually asked for diagnosis and preoperative planning. Koval KJ el al. in 2008 has said that traction views are helpful in comminution and high energy fractures for determining implant selection. Sub trochanteric fractures require full length femur AP and lateral radiographs for implant length selection. If long nail implants are selected, AP and lateral radiographs of affected proximal femur to knee are required with attention to femoral bow and medullary canal diameter.[17] Traction with internal rotation views may benefit preoperatively for aiding in selection of definitive internal fixation.[17] Rizzo PF in 1993 stated that computerised tomography (CT) and magnetic resonance imaging (MRI) are required in diagnosis of a non-obvious and atypical fractures in high energy trauma patients. In many institutions, fluoroscopic C-ARM view in the operating rooms has reduced the need for preoperative lateral radiographs.[18]

CONCLUSIONS

Fracture healing was slow when compared with regular dynamic hip screw. Modified dynamic hip screw

significantly limits the collapse at fracture site. When modified dynamic hip screw is used in management of unstable trochanteric fracture, weight bearing mobilisation should be delayed to improve the outcome.

Modified dynamic hip screw has shown improved results as compared to normal dynamic hip screw in treating unstable trochanteric fracture.

Limitations

- Small sample size.
- Other forms of fixation of trochanteric fractures were not compared in this study.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

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