Intertrochanteric Hip Fracture Collapse and Patient Function

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Abstract

The purpose of this study was to assess the relationship between fracture collapse and patient function for surgically repaired unstable intertrochanteric hip fractures. Postoperative collapse was measured using radiographic analysis and compared with patient functional outcome as measured by the validated Hip Fracture Functional Recovery Score. It was found that increased fracture collapse correlated with higher functional outcome scores, which suggests the benefits of compression during healing outweigh the potential biomechanical compromise associated with collapse.

Introduction

Intertrochanteric hip fractures are a common cause of hospitalisation in geriatric patients, and represent a considerable cost burden on the health care system [1]. These fractures occur in the region between the greater and lesser trochanters (Fig. 1) and usually require surgical repair. Fractures where the lesser trochanter has been displaced are classified as unstable intertrochanteric fractures (Fig. 2). The displacement of the lesser trochanter means there is a loss of bony continuity medially that is necessary to resist the high compressive forces through the hip. As a result, surgical fixation of unstable intertrochanteric fractures is a challenge, and has an average failure rate of 15% [2].

Modern internal fixation devices used to repair intertrochanteric hip fractures are designed to allow controlled collapse during healing by sliding at a fixed angle. This is important because the bone near the screw tip in these patients is often quite weak and soft (osteoporotic), and the forces exerted on the hip are quite high. Even sitting and walking generate forces several times body weight and can cause the femoral head to collapse. When this happens the screw can cut through the soft bone, damaging the hip joint surface. This requires a second surgery to correct. This phenomenon, called screw cut-out, used to be very common when rigid fixation devices were used. Now, newer devices have reduced the failure rate by allowing the screw shaft to slide with the bone as it collapses. However, there is controversy in the orthopaedic community regarding the effect of allowing the bone to shorten and lateral offset of the femur to decrease on patient outcomes. I define

Figure 1. Hip Anatomy.
Intertrochanteric fractures occur in the shaded region

Figure 2. Unstable Intertrochanteric hip fractures involve the displacement of the lesser trochanter (shaded).
shortening as a decrease in length of the femur as measured from the top of the femoral head along the vertical axis, and I define lateral offset as the horizontal distance from the inner edge of the femoral head to the outer tip of the greater trochanter. Some collapse may promote predictable healing by avoiding distraction, which is space between fracture fragments, and delayed healing. Sliding screws should reduce the incidence of screw cut out, but it is unclear if excessive shortening has a detrimental effect on patient function. Studies in fractures of the femoral neck showed that shortening during healing results in a significant decrease in patient functional ability [3, 4]. However, little research has been done to determine the relationship between shortening in intertrochanteric fractures and patient function.

The objective of this study is to investigate the correlation between fracture collapse during healing (as assessed by bone shortening and changes in lateral offset), and the functional outcome of patients with unstable intertrochanteric hip fractures. Biomechanically, collapse is expected to correlate to decreased patient function because it can limit the effectiveness of the hip abductor muscle (Gluteus Medius), which is important for stabilising the pelvis when walking. Shortening decreases the distance between the hip abductor muscle attachments, meaning the muscle is effectively lengthened (Fig. 3). As a result, muscle contractions cannot exert as great a force on the hip joint. Similarly, decreasing lateral offset results in a shorter lever arm for the abductor muscles. Both of these changes result in the decreased ability of the abductors to apply torque to the hip joint. Numerous studies have shown that abductor lever arm length is related to the strength and function of the muscle [5, 6]. With the resultant weakness, the function of the patient, especially their mobility, is expected to be compromised. Based on this anatomical reasoning, I predicted that excessive shortening and decreased lateral offset would correlate with poorer patient outcomes.

Methods

To assess the degree of shortening and lateral offset that occurred during healing, measurements were made on radiographic images. Patient function was assessed using a questionnaire-based validated outcome measure, the Hip Fracture Functional Recovery Score (HFS) [7]. This questionnaire assessed mobility and ability to perform activities of daily living.

Patient information and radiographic images were obtained from research databases at the Royal Columbian Hospital. Eligible patients were over the age of 60 (average age was 83.1). Exclusion criteria consisted of patients with previous hip fractures on the affected side, non-ambulatory (bed ridden) patients, and patients with limited life expectancy because of
other significant medical concerns. Additionally, individuals who could not communicate in English were excluded because of the need to understand the questions on the HFS assessment. 68 patients were randomly selected from the database of 162 eligible patients. Of these, 6 had significant rotation that did not allow for accurate comparison, 15 died or were lost to follow-up, and 24 had missing films or functional outcome scores, leaving 23 patients. The sex distribution was 6 male and 17 female patients.

Two radiographic images were taken from each patient: one within two days of surgery and one taken at the time of healing (at least three months post operatively). When X-rays beyond three months were available the latest image was used (except in cases where significant rotation or poor image quality threatened the measurement accuracy). The rotation of the images was qualitatively assessed by looking at the profile of the rectangular plate and the screw angle, which change with rotation. Only images with minimal or no rotation were used. X-ray images and HFS scores were provided by the Simon Fraser Orthopaedic Fund.

To assess the shortening in the vertical plane, the distance between two lines perpendicular to the straight edge of the fixation plate was measured (Fig. 4). One was drawn tangent to the top of the femoral head, and the other passed through a reference point at the base of the screw shaft. The reference point was centred at the border of the screw shaft and barrel. In some patients a newer sliding fixation plate was used, which allowed shortening along the plate as well. In these cases an additional measurement of the distance from a line shaft reference point to another line at the edge of the fixation account for the sliding plate. Because only the change in length is considered, this extra measurement does not affect comparison between the two devices.

To assess shortening in the horizontal plane (lateral offset), the distance between two lines parallel to the fixation plate were measured (Fig. 5). One line passed through the reference point at the base of the screw shaft, and the other was drawn tangent to the inner edge of the femoral head.

Using callipers, the width of the screw shaft was measured on each image. The known diameter of the screw was used to correct for the different magnification of the X-rays. After correcting for magnification, the change in both the vertical and horizontal measurements from the baseline to the time of healing was calculated. Measuring from the edges of the

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**Figure 4. Assessment of vertical shortening.** The distance $L_1$ was measured on all patient X-rays. $L_2$ was measured only on patients with sliding plate fixation to account for the additional movable piece.

**Figure 5. Assessment of changes in Lateral offset.** The distance $L$ between the vertical lines was measured.
femoral head instead of the screw tip eliminates the need to calculate changes of the screw position in the head.

To assess the reliability of the radiographic measurements, 25% of the sample size was re-measured after a two week period. Intraobserver reliability was calculated to have a Cohen’s Kappa value of 0.9691, which is considered almost perfect agreement [8].

**Results**

The average vertical shortening was 1.50cm (range -0.5-3.71cm), and the average lateral offset was a decrease of 0.50cm (range -0.4-2.45cm). The average change in patient HFS was a decrease 9.4 points out of a maximum score of 44. Figure 6 shows a statistically significant correlation was found between increased vertical shortening and patient function (r=0.58). It was found that greater vertical shortening correlated with smaller decreases in HFS. The slope of the best fit line as determined by linear regression is 0.23 Figure 7 shows a similar trend with lateral offset, but this correlation was not statistically significant for the number of replicates measured (r=0.36). Neither age nor sex were found to be significant predictors of whether shortening would occur. Although there was a trend for the final HFS to be lower with increased patient age, there was no significant correlation between patient age and the change in HFS.

**Discussion**

Virtually all patients have a decrease in function after hip surgery. I chose to analyse the change in HFS instead of final score alone because it helps minimise the effects of the differences in the patient’s initial function. It was found that the decline in function was minimised with greater degrees of vertical shortening. This is surprising because, as discussed above, there are expected negative biomechanical effects when lever arm of the hip abductor muscle is decreased. It is possible that the amount of shortening was not sufficient to noticeably alter the hip abductor function. Furthermore, it is known that compression facilitates bone healing by preventing distraction. When the bone fragments are not held together, the healing time is much longer because more new bone must grow to fill in the spaces. If controlled collapse optimizes the healing, then the negative effects on
hip abductor function may be negligible in comparison to the benefits of having the hip healed sooner.

The slope of the line found by linear regression was 0.23, meaning that on average the change in HFS had 0.23 points less decline for every centimeter of shortening. Considering the average shortening was 1.5cm, the trend for improved functional outcome is not very dramatic. However, because the expected result was a large, negative correlation, this finding may still have important practical significance. It suggests that using sliding fixation devices that allow for compression is desirable, given the advantages of avoiding distraction and screw cut-out. These results are also relevant to the controversy between rigid fixation devices that maintain normal anatomy and sliding constructs that allow collapse. The results suggest that the patient outcome is better when the fracture is allowed to collapse.

Previous studies on femoral neck fractures found that collapse correlated with worsened patient function. I speculate that this discrepancy is caused by the different fracture location. Intertrochanteric fractures occur over a larger region, and may be more prone to distraction. As discussed above, the benefits of preventing this distraction may outweigh the weakening effects of the abductor muscles. Further investigation is necessary to determine whether this contributes to the result.

Possible factors that contribute to variation in the data include differences in fracture type, rehabilitation and the patient's response to injury. Although all fractures were unstable intertrochanteric fractures, the exact location of the break and the initial amount of distraction may affect successful healing and patient outcome scores. Secondly, the patients' willingness and ability to follow the standardized protocol for rehabilitation could affect their physical function. Finally, although the HFS is a standard validated assessment of patient function, there likely exists variation in how participants interpret questions and evaluate their abilities.

One limitation of this study was the sample size. This was designed as a pilot study to develop a measurement technique, assess measurement reliability, and see if there are any trends that merit further investigation. It is possible that a significant result could have been obtained for the lateral offset correlation with more replicates.

Conclusion

Although more measurements are required to confirm the findings of this study, the preliminary results suggest that controlled collapse that allows shortening and decreased lateral offset during healing improves patient outcome. This means that using sliding fixation devices that allow for compression is desirable, given the advantages of avoiding distraction and screw cut-out. These results help address debate between rigid fixation that maintains normal anatomy and sliding constructs that allow collapse, suggesting that the patient outcome is better when fracture collapse occurs.
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References


