

Do Coronal-Plane Fragments in Intertrochanteric Fractures Affect Operative Outcomes? A 10-Year Retrospective Analytic Study of Postoperative Outcomes at Bangkok Hospital

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Abstract

OBJECTIVES: To compare post-operative outcomes between patients with coronal and non-coronal plane fractures, and to assess the quality of fixation and reduction techniques.

MATERIALS AND METHODS: A retrospective review of 73 cases from 2012-2022 at Bangkok Hospital, focusing on post-operative outcomes; primary outcome is union time, and secondary outcomes are post-operative parameters, and complications.

RESULTS: Patients with coronal fractures demonstrated increased fracture instability and altered fixation outcomes compared to non-coronal fractures. There is no significant difference between coronal and non-coronal plane fractures groups in terms of union time (coronal plane; 3 months, non-coronal plane; 3.1 months, p -value = 0.632), neck-shaft angle (coronal fracture mean is 133.6 degree, non-coronal fracture mean is 134.9 degree, p -value = 0.465), cortical support index, tip-apex distance (coronal fracture mean is 2.0 cm, non-coronal fracture mean is 2.0 cm, p -value = 0.830), garden alignment index also shows no statistical difference (p -value = 0.7) between the 2 groups. However, proper reduction and fixation quality significantly impacted outcomes.

CONCLUSION: Presence of coronal plane fracture in intertrochanteric fractures does not affect the union time and complication rates, provided the reduction and fixation quality is optimized in both anteroposterior (AP) and lateral planes. Therefore, surgeons should always carefully assess the preoperative radiographs for the presence of unstable fracture patterns and provide careful reduction and fixation to ensure optimal fixation stability.

Keywords: intertrochanteric fracture, coronal plane fracture, reduction quality, internal fixation, tip-apex distance, fracture union

Intertrochanteric fractures are a significant concern in the elderly, often resulting from low energy falls due to osteoporosis. The prevalence of hip fractures is increasing worldwide, with projections suggesting that the number of cases will reach approximately 6.3 million by 2050, driven by an aging population.¹ Kaufer et al² report factors affecting stability of intertrochanteric fixation, quality of bone (osteopenia, osteoporosis), fracture configuration (fragment geometry), quality of reduction, implant options, and implant position.

In previous studies, several factors have been widely recognized as having significant impact on the outcomes of internal fixation procedures. These factors include: Quality of Reduction: The Garden Alignment Index³⁻⁵, as assessed on post-operative radiographs, is a key measure. This index is evaluated in both anteroposterior (AP) and lateral views: normal values are approximately 160 degrees in the AP view, normal values are approximately 180 degrees in the lateral view, Neck-Shaft Angle^{3,4,6}: Measured on the anteroposterior radiograph, with normal values ranging from 125 to 145 degrees. Cortical Support Index⁷: evaluated in both anteroposterior and lateral views. This index assesses the quality of reduction, particularly

focusing on the anteromedial cortex. Implant Positioning: The Tip-Apex Distance^{8,9}(TAD) is a critical measure, assessed in both anteroposterior and lateral views. The optimal TAD should be less than 25 mm. These parameters have been extensively studied and are considered crucial in predicting the success of internal fixation procedures. They provided quantitative measures for assessing the quality of reduction perioperatively.

A study by Cho et al.¹⁰ revealed that plain radiographs have lower sensitivity in detecting coronal plane fractures in the intertrochanteric region, while computed tomography (CT) scans are more effective in identifying these fractures. The underdiagnosis of coronal plane fractures on radiographs can cause bursting of the fracture site during reaming, which significantly affects treatment outcomes. Intertrochanteric fractures management can be more complex due to the presence of coronal plane fractures, which is an additional challenge due to difficulty in reduction and fixation. However, there is still no standard recommendation in the literature for specific management of the coronal plane fracture.

Proper fixation and reduction are critical in managing intertrochanteric fractures, particularly those involving coronal plane components. Achieving accurate reduction and secure fixation is particularly difficult in coronal fractures due to the variability in fragment geometry and the challenges in aligning the coronal fragments.¹⁰

This study aims to compare the post-operative outcomes between patients with coronal and non-coronal plane fractures, emphasizing the quality of fixation and reduction techniques. The findings highlight the importance of advanced reduction methods and tailored surgical techniques to improve outcomes in patients with complex intertrochanteric fractures.

Material and Methods

This retrospective chart review was conducted at Bangkok Hospital, the study protocol was approved by the Ethics

Committee of our institute (Approval number COE 2024-30), examining patients treated for intertrochanteric fractures between 2012 and 2022. We found 268 patients presenting with intertrochanteric fractures. 162 patients were excluded due to a lack of a preoperative CT scan, 33 patients were excluded due to insufficient or no follow-up data. Of the 73 patients in the study, the cohort was categorized into coronal and non-coronal fracture group based on pre-operative CT scan (Figure 1).

The sample size requirement for this study is 68 patients, as referenced from data in previous literature^{10,11} provided the following information: the mean of the HHS Score at the final follow-up for patients with coronal fragments was 78, with a standard deviation (SD) of 5.74, while for patients without coronal fragments, the mean HHS Score was 74, with an SD of 4.21. We set the significance level (alpha) at 0.05 and aimed for a statistical power of 90%. Consequently, the calculated sample size for each group indicated that a total of 34 participants are needed in both the group with coronal fragments and the group without coronal fragments.

All patients were treated with open reduction and internal fixation with dynamic hip screw or closed reduction and internal fixation with cephalomedullary nail depends on fracture characteristic of each patient. Routine postoperative rehabilitation, partial weight bearing with walker, were managed in every patient.

We defined coronal plane fracture according to the study from Cho et al¹⁰: A fracture line starting between the anterior and posterior margins along the trochanteric summit extending in the frontal plane on the lateral view. The classified coronal fracture line (Figure 2) which is seen on CT scan depends on the fracture line exists location on the lateral view:

- Greater trochanter (GT) fragment: single coronal fracture line starting over the center of the trochanteric summit that transverses obliquely in a posteroinferior direction exit through the intertrochanteric cortex.

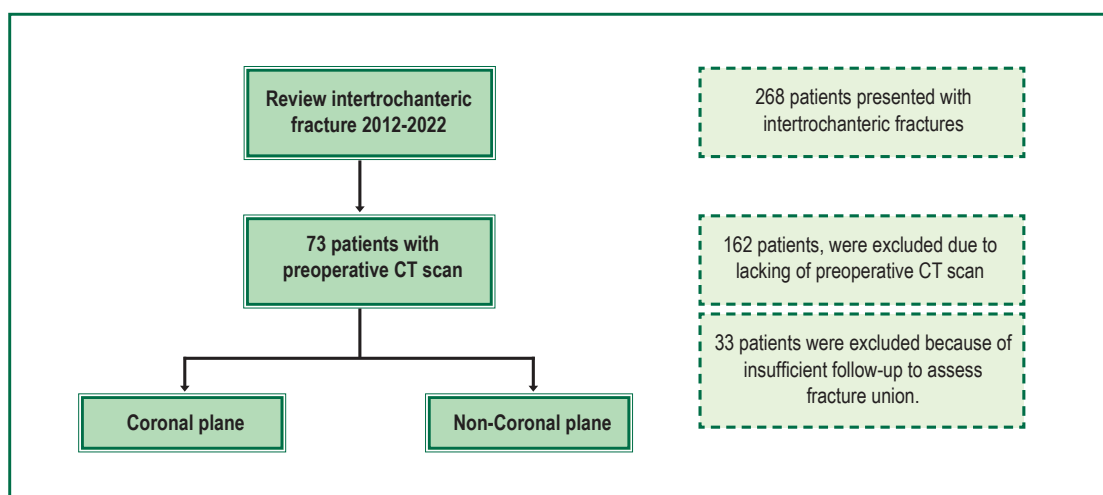


Figure 1: Algorithm for retrospective chart review intertrochanteric fracture 2012-2022.

- Greater and lesser trochanter (GLT) fragment: single coronal fragment line starting over the trochanteric summit that transverses in a posteroinferior direction to exit through and around the lesser trochanter without involving posteromedial cortex.
- Greater trochanter, lesser trochanter, and posteromedial cortex (GLPC) fragment: single coronal fracture line starting near the anterior margin of the trochanteric summit that transverse in a less oblique fashion to exit through the posteromedial cortex of the proximal femur.

Fracture configuration was classified according to the AO/OTA classification.¹² An unstable configuration was defined as a reverse obliquity fracture, posteromedial comminution, extension into the subtrochanteric region, lateral wall fracture, basicervical pattern, or failure of reduction.

Others parameters, namely operative time, blood loss, and complication rates were recorded. We also recorded union time based on clinical and radiological findings. We diagnosed union according to OPD record, which patients can be fully weight bearing and/or radiograph reveals 4 cortical bridging. We defined blade migration as further displacement of blade relatively to femoral head after fixation more than 2 mm.

Radiological parameters

Radiological data were collected using post-operative radiographic imaging. Key parameters included reduction quality, implant positioning, and fixation metrics such as the tip-apex distance (TAD), cortical support index, garden alignment index, neck-shaft angle, and shortening.

Neck-shaft angle^{3,4,6}: The angle formed by a line passing through the center axis of the femoral neck intersecting with a line passing through the center axis of the femoral shaft. The normal range is approximately 125-145 degrees.

Cortical support index⁷: In an anteroposterior radiograph, the relationship between the medial cortex of the femoral head-neck fragment and the shaft fragment is assessed, using the shaft fragment as a reference. If the medial cortex of the head-neck fragment is medial to the shaft fragment, it's considered 'positive'. If they're at the same level, it's 'neutral'. If it's lateral to the shaft fragment, it's 'negative'. In a lateral radiograph, the relationship between the anterior cortex of the femoral head-neck fragment and the shaft fragment is assessed, using the shaft fragment as a reference. If the anterior cortex of the head-neck fragment is anterior to the shaft fragment, it's considered 'positive'. If they're at the same level, it's 'neutral'. If it's posterior to the shaft fragment, it's 'negative'.

Garden alignment index³⁻⁵: In an anteroposterior radiograph, it's the angle formed by the trabecular line extending from the acetabulum to the femoral neck, intersecting with the line drawn along the medial cortex of the femoral shaft. The normal value is 160 degrees. In a lateral radiograph, it's the

angle formed by a line passing through the center of the femoral neck axis intersecting with a line drawn from the center of the femoral head to the point where the circumference of the femoral head intersects the central neck axis line. The normal value is 180 degrees.

- **Tip-apex distance^{8,9}:** The sum of the distances from the tip of the fixation device to the apex of the femoral head in both anteroposterior and lateral radiographs. The normal value should not exceed 25 mm.
- **Shortening difference:** A line is drawn perpendicularly to the line which is drawn vertically in the middle of the tear drop. Another line is drawn parallel with the first line at the apex of lesser trochanter. We compared the difference between these two lines and reported the findings as a percentage. We measured the shortening difference by comparing the preoperative and postoperative radiograph.

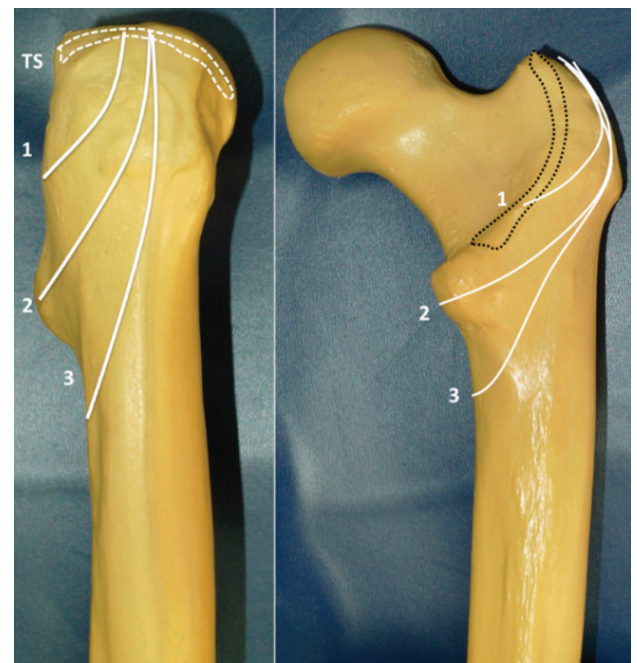


Figure 2: Reproduced from Cho et al.¹⁰¹ 1) Greater trochanter (GT) fragment: single coronal fracture line starting over the center of the trochanteric summit that transverse obliquely in a posteroinferior direction exit through the intertrochanteric cortex. 2) Greater and lesser trochanter (GLT) fragment: single coronal fragment line starting over the trochanteric summit that transverses in a posteroinferior direction to exit through and around the lesser trochanter without involving posteromedial cortex. 3) Greater trochanter, lesser trochanter, and posteromedial cortex (GLPC) fragment: single coronal fracture line starting near the anterior margin of the trochanteric summit that transverse in a less oblique fashion to exit through the posteromedial cortex of the proximal femur.

Statistical analysis

Descriptive statistics were used to summarize the data, and comparative analyses were performed using two-sample *t*-test used to compare the means between the coronal and non-coronal groups: age, operative time, blood loss, follow up duration, neck-shaft angle, and shortening difference. Fisher's exact test was used to compare categorical variables between groups: sex, mechanism of injury, type of coronal fragment, and coronal fragment line. Pearson's chi-square tests was used to analyze associations between categorical variables: fracture type(stable/unstable) and cortical support index. Other statistical metrics: tip-apex distance, garden alignment index, and shortening percentage. A *p*-value of < 0.05 was considered statistically significant.

Results

A total of 73 patients were included, with 28 in the non-coronal fracture group and 45 in the coronal fracture group. The mean age was higher in patients with coronal fractures (82.2 ± 9.3 years) compared to those without (75.0 ± 14.7 years), with a statistically significant difference ($p = 0.013$) (Table 1). Most patients were over 60 years old, reflecting the typical demographic profile for hip fractures. 10 Fracture configurations of both AO/OTA classification and fracture type (stable/unstable) are statistically significant differences between the two groups ($p < 0.001$).

Between groups, patients who presented with coronal plane fractures were treated with closed reduction and internal fixation with cephalomedullary nail (95.6%) more than open reduction and fixation with dynamic hip screw (4.4%), with a statistically significant difference ($p = 0.002$).

Union Outcome (Table 2) between coronal and non-coronal fracture shows no significant difference between the two groups. The mean union time in coronal plane fracture is 3 months (± 1), in non-coronal plane fracture is 3.1 months (± 0.8) ($p = 0.632$).

Radiographic parameters show no significant difference between the two groups: coronal and non-coronal fractures. Neck-shaft angle (Table 3) in non-coronal fracture mean is 134.9 degree (± 7.8) and in coronal fracture mean is 133.6 (± 7.0), which shows no statistical difference ($p = 0.465$). Cortical support index (Table 3) between the two groups also shows no statistical difference ($p = 0.423$). Tip-apex distance (Table 4) in coronal fracture mean is 2.0 cm (± 0.5) and in non-coronal fracture mean is 2.0 cm (± 0.6), which shows no statistical difference between the two groups ($p = 0.830$). Garden alignment index also shows no statistical difference between the two groups ($p = 0.7$). Difference of shortening between each group is statistically different ($p = 0.024$), coronal group is -0.1 ± 0.1 , meanwhile non-coronal group is -0.2 ± 0.2 cm.

Table 1: Baseline Characteristics (n=73).

Variables	Non-coronal plane fracture (n = 28)	Coronal plane fracture (n = 45)	<i>p</i> -value
Age (years), mean $\pm$ SD	75.0 $\pm$ 14.7	82.2 $\pm$ 9.3	0.013*
Age category (years), n (%)			0.195
18 – 60	4 (14.3)	2 (4.4)	
> 60	24 (85.7)	43 (95.6)	
Sex, n (%)			0.201
Male	6 (21.4)	16 (35.6)	
Female	22 (78.6)	29 (64.4)	
ASA, n (%)			0.863
1	4 (14.3)	4 (8.9)	
2	19 (67.9)	32 (71.1)	
3	5 (17.9)	9 (20.0)	
Mechanism, n (%)			1.000
High energy	1 (3.6)	1 (2.2)	
Low energy	27 (96.4)	44 (97.8)	
AO/OTA classification, n (%)			< 0.001***
31A1	6 (21.4)	0 (0.0)	
31A2	14 (50.0)	43 (95.6)	
31A3	8 (28.6)	2 (4.4)	
Operative time (min), mean $\pm$ SD	92.7 $\pm$ 41.0	85.7 $\pm$ 36.5	0.452
Blood loss (mL), mean $\pm$ SD	223.9 $\pm$ 230.5	154.7 $\pm$ 102.2	0.082
Fracture type, n (%)			< 0.001***
Stable	7 (25.0)	0 (0.0)	
Unstable	21 (75.0)	45 (100.0)	
Operation, n (%)			0.002**
CRIF (cephalomedullary nail)	19 (67.9)	43 (95.6)	
ORIF (DHS)	9 (32.1)	2 (4.4)	

Note: Data are presented as mean $\pm$ SD or n (%). Continuous variables were analyzed using Student's *t*-test. Categorical variables were analyzed using Pearson's chi-square test or Fisher's exact test. $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

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Operative time and blood loss were comparable between both groups (Table 1). In non-coronal plane fractures both operative times and blood loss are higher than in coronal plane fractures group but not statistically significant (Operative time (min); non-coronal plane 92.7 ± 41.0 vs coronal plane 85.7 ± 36.5 ($p = 0.452$), Blood loss (mL); non-coronal plane 223.9 ± 230.5 vs coronal plane 154.7 ± 102.2 ($p = 0.082$)).

Patients with coronal fractures required more frequent revision surgeries due to blade migration. We found three cases presented with late blade migration (Table 5), (Figure 3). All three patients are in the coronal plane fracture group, however there is no statistically significant difference between each group ($p = 0.281$).

Table 2: Union Outcomes.

Variables	N	Non-coronal plane fracture (n = 28)	Coronal plane fracture (n = 45)	p-value
Union time (months), mean $\pm$ SD	57	3.1 ± 0.8	3.0 ± 1.0	0.632

Note: Union-time data were available for 57 of 73 patients. Data are presented as mean $\pm$ SD. The p-value was calculated using the two-sample t-test.

Table 3: Radiological Outcomes (n = 73).

Variables	Non-coronal plane fracture (n = 28)	Coronal plane fracture (n = 45)	p-value
Neck-shaft angle (degrees), mean $\pm$ SD	134.9 ± 7.8	133.6 ± 7.0	0.465
Neck-shaft angle category, n (%)			0.517
Normal (125 – 145)	22 (78.6)	39 (86.7)	
Abnormal	6 (21.4)	6 (13.3)	
Cortical support index, n (%)			0.259
Neutral/Neutral	17 (60.7)	23 (51.1)	
Neutral/Positive	3 (10.7)	1 (2.2)	
Neutral/Negative	2 (7.1)	7 (15.6)	
Positive/Neutral	3 (10.7)	2 (4.4)	
Positive/Positive	0 (0.0)	2 (4.4)	
Positive/Negative	1 (3.6)	3 (6.7)	
Negative/Neutral	0 (0.0)	3 (6.7)	
Negative/Positive	2 (7.1)	1 (2.2)	
Negative/Negative	0 (0.0)	3 (6.7)	
Simplified cortical support index, n (%)			0.423
Neutral/Neutral	17 (60.7)	23 (51.1)	
Others	11 (39.3)	22 (48.9)	

Note: Data are presented as mean $\pm$ SD or n (%). Continuous variables were analyzed using the two-sample t-test. Categorical variables were analyzed using Pearson's chi-square test or Fisher's exact test.

Table 4: Implant Position and Shortening Outcomes.

Variables	Non-coronal plane fracture (n = 28)	Coronal plane fracture (n = 45)	p-value
Tip-apex distance (cm), mean $\pm$ SD	2.0 ± 0.6	2.0 ± 0.5	0.830
Tip-apex distance category, n (%)			0.544
Normal	22 (78.6)	38 (84.4)	
Abnormal	6 (21.4)	7 (15.6)	
Garden alignment index, n (%)			0.700
Normal ($160^\circ/180^\circ \pm 10^\circ$)	26 (92.9)	40 (88.9)	
Abnormal	2 (7.1)	5 (11.1)	
Shortening percentage (%), mean $\pm$ SD†	69.5 ± 33.2	85.4 ± 39.9	0.109
Difference in shortening (cm), mean $\pm$ SD†	-0.2 ± 0.2	-0.1 ± 0.1	0.024*
Difference in shortening category†, n (%)			0.440
Shortened	19/24 (79.2)	26/37 (70.3)	
Longer	5/24 (20.8)	11/37 (29.7)	

Note: Data are presented as mean $\pm$ SD or n (%). † Available data in 61 patients. Continuous variables were analyzed using the two-sample t-test. Categorical variables were analyzed using Pearson's chi-square test or Fisher's exact test. $p < 0.05$

Table 5: Complications.

Variables	Non-coronal plane fracture (n = 28)	Coronal plane fracture (n = 45)	p-value
Blade migration, n (%)			0.281
No	28 (100.0)	42 (93.3)	
Yes	0 (0.0)	3 (6.7)	

Note: Data are presented as n (%). Categorical variables were analyzed using Fisher's exact test.

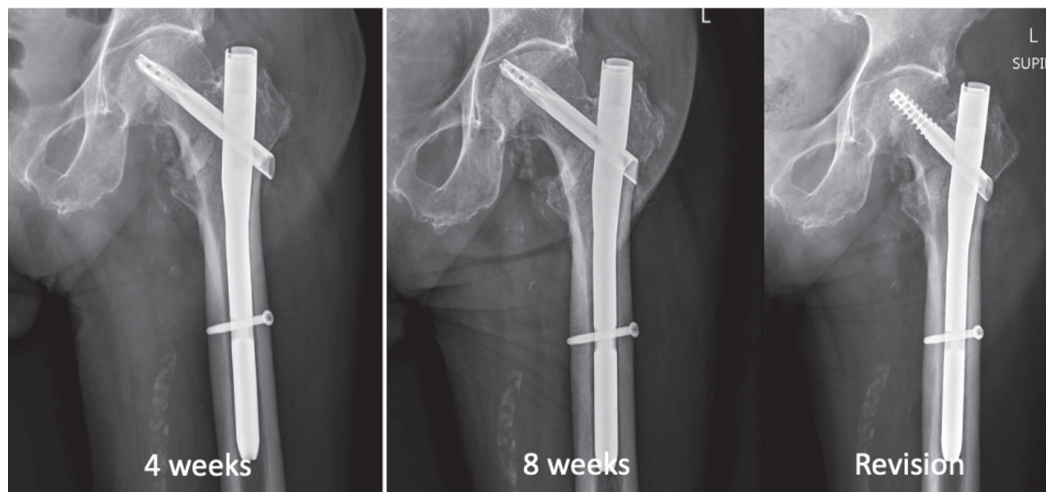


Figure 3: A 77-year-old male underwent closed reduction and internal fixation with a cephalomedullary nail for an intertrochanteric fracture. After 8 weeks of fixation, implant migration occurred, and revision was performed with a cephalomedullary nail.

A total of 45 patients with coronal plane fracture configuration were categorized into three subtypes (Table 6) as aforementioned: GLPC ($n = 14$), GLT ($n = 15$), and GT ($n = 16$). Operative parameters among the three coronal-plane fracture subtypes are presented in Table 6. The mean operative time was 83.9 ± 34.1 minutes in the GLPC group, 78.8 ± 24.2 minutes in the GLT group, and 93.8 ± 47.4 minutes in the GT group. Mean intraoperative blood loss was 185.7 ± 135.1 mL, 109.3 ± 66.6 mL, and 170.0 ± 86.6 mL in the GLPC, GLT, and GT groups, respectively.

Mean postoperative neck-shaft angles were $133.6 \pm 5.2^\circ$, $132.4 \pm 7.2^\circ$, and $134.8 \pm 8.4^\circ$ in the GLPC, GLT, and GT

groups, respectively. The distribution of normal and abnormal neck-shaft angle categories did not differ significantly among the groups ($p = 0.859$). Similarly, no significant difference was observed in cortical support index ($p = 0.259$). Mean tip-apex distances were 1.9 ± 0.5 cm, 1.9 ± 0.5 cm, and 2.2 ± 0.5 cm in the GLPC, GLT, and GT groups, respectively. The proportion of patients with an acceptable tip-apex distance did not differ significantly among the groups ($p = 0.408$). For Garden alignment index, although no statistically significant difference was detected ($p = 0.067$), the GLT group showed a higher proportion of abnormal alignment (26.7%) compared with GLPC (0%) and GT (6.3%).

Table 6: Comparison of Outcomes Among Types of Coronal Plane Fractures ($n = 45$).

Variables	GLPC ($n = 14$)	GLT ($n = 15$)	GT ($n = 16$)	p-value
Operative time (min), mean $\pm$ SD	83.9 ± 34.1	78.8 ± 24.2	93.8 ± 47.4	
Blood loss (mL), mean $\pm$ SD	185.7 ± 135.1	109.3 ± 66.6	170.0 ± 86.6	
Neck-shaft angle (degrees), mean $\pm$ SD	133.6 ± 5.2	132.4 ± 7.2	134.8 ± 8.4	
Neck-shaft angle category, n (%)				0.859
Normal	13 (92.9)	13 (86.7)	13 (81.3)	
Abnormal	1 (7.1)	2 (13.3)	3 (18.8)	
Cortical support index, n (%)				0.259
Neutral/Neutral	7 (50.0)	11 (73.3)	5 (31.3)	
Neutral/Positive	0 (0.0)	1 (6.7)	0 (0.0)	
Neutral/Negative	3 (21.4)	2 (13.3)	2 (12.5)	
Positive/Neutral	0 (0.0)	0 (0.0)	2 (12.5)	
Positive/Positive	1 (7.1)	0 (0.0)	1 (6.3)	
Positive/Negative	0 (0.0)	0 (0.0)	3 (18.8)	
Negative/Neutral	1 (7.1)	1 (6.7)	1 (6.3)	
Negative/Positive	1 (7.1)	0 (0.0)	0 (0.0)	
Negative/Negative	1 (7.1)	0 (0.0)	2 (12.5)	
Tip-apex distance (cm), mean $\pm$ SD	1.9 ± 0.5	1.9 ± 0.5	2.2 ± 0.5	
Tip-apex distance category, n (%)				0.408
Normal	12 (85.7)	14 (93.3)	12 (75.0)	
Abnormal	2 (14.3)	1 (6.7)	4 (25.0)	
Garden alignment index, n (%)				0.067
Normal ($160^\circ/180^\circ \pm 10^\circ$)	14 (100.0)	11 (73.3)	15 (93.8)	
Abnormal	0 (0.0)	4 (26.7)	1 (6.3)	

Note: Data are presented as mean $\pm$ SD or n (%). Categorical variables were analyzed using Fisher's exact test or Pearson's chi-square test.

Discussion

This study demonstrates that coronal plane fractures may present challenges in achieving optimal fixation and reduction. However, most postoperative outcomes did not differ significantly between the coronal and non-coronal fracture groups. The high prevalence of coronal fragments in intertrochanteric fractures, especially in complex 31-A2 patterns and elderly patients, calls for careful preoperative planning to achieve acceptable intraoperative alignment.¹⁰

According to our results, the presence of coronal fractures and non-coronal fractures are not associated with outcome including union time. The most important factors associated with optimal outcomes remain the postoperative alignment, which are tip-apex distance, garden alignment index, neck-shaft angle, cortical support index, and shortening. These findings were consistent with previous data as highlighted by Li et al¹¹, who found that better reduction quality was associated with lower complication rates and improved clinical outcomes in intertrochanteric fractures.

In our study, the only statistically significant difference was observed in postoperative shortening. The mean difference in shortening was -0.1 ± 0.1 cm in the coronal-plane fracture group and -0.2 ± 0.2 cm in the non-coronal fracture group ($p = 0.024$). This finding may be related to differences in fixation methods and fracture characteristics between the groups, including the more frequent use of cephalomedullary nails and the higher prevalence of unstable fracture patterns in the coronal-plane fracture group; however, it should be interpreted cautiously.

Coronal fractures exhibited a higher rate of fixation failures; however, the difference between the groups was not statistically significant, indicating that achieving anatomical reduction in these cases may be particularly challenging. The tip-apex distance (TAD) has been reported as a significant predictor of fixation failure, with TADs greater than 25 mm strongly associated with screw cutout and fixation failure, emphasizing the importance of accurate implant positioning.^{8,9} In coronal fractures, improper reduction may lead to increased rates of varus deformity and implant-related complications.¹³

We found three cases presented with blade migration, one case was revised with repositioning and reduction with cephalomedullary nail, and two cases were revised with total hip arthroplasty due to acetabular surface injury from implant migration. Although all three cases involved a coronal plane fracture, the primary cause of failure in all three cases was due to a failure in achieving proper cortical support which was one of the important reduction parameters. Despite the result not being statistically significant, due to the limited number of patients studied, the presence of coronal plane fracture may potentially be an indirect sign of poor bone quality which contributes to the difficulty in achieving strong fixation construct. Using this finding for clinical application should be interpreted cautiously.

Proper reduction and cortical support, particularly the anteromedial cortical reduction technique, were crucial for maintaining stability and reducing complications. Li et al¹¹ demonstrated that the quality of reduction of anteromedial cortices, significantly affected post-operative outcomes, with poor reduction linked to higher rates of mechanical failure, including implant cutout and excessive sliding. The presence of coronal fragments, identified in over 60% of cases in our institute, noting the difficulty of achieving stable fixation and reduction with conventional techniques¹⁰. We agree that the inability to address and stabilize the split of coronal fragments would result in fixation instability.

In our study, operative times and blood loss levels are higher in the non-coronal plane fracture than in coronal group because of fixation techniques and implant options. In the coronal group, we usually closed reduction and internal fixation with cephalomedullary nail that allow smaller incision and faster implant fixation.

Our outcomes were not significantly different, owing to our standardized surgical techniques that ensure optimal fracture reduction and fixation stability in both AP and lateral planes. Hence, we emphasized surgical technique before nail insertion in the coronal plane fracture to achieve optimal fracture alignment.

Regarding cephalomedullary nailing in intertrochanteric fractures, our key surgical steps are:

- Optimal insertion points in both AP and lateral planes.
- Proximal reaming starts with small reamer. We use an army-navy type retractor to counteract the reaming sleeve to prevent lateralization. Reaming should be performed with soft-tissue like feeling, no forceful push and pull of the reamer during reaming, to ensure the reamed canal is most optimal.
- Fluoroscopy check in AP and lateral to confirm the alignment during reaming and after reaming.
- Reduction of fractures. There are several methods we use to obtain reduction maneuvers, including closed manipulation, percutaneous bone hook, collinear clamps. If closed reduction fails to obtain satisfactory reduction, open reduction is made.
- The rest of surgical steps are similar to fixation of intertrochanteric fractures, in general.

The choice of implant and reduction technique must be individualized based on fracture characteristics to ensure stability and reduce the risk of complications such as implant failure and non-union. According to our result the cephalomedullary nail was found to be effective in achieving stable fixation in unstable fractures, offering shorter operative times and less blood loss; however, concerns about high re-operation rates may persist, especially in cases with coronal fractures.

The findings of this study are consistent with existing literature, highlighting the importance of reduction quality in managing intertrochanteric fractures. Kaufer et al² emphasized that the effectiveness of intertrochanteric fracture management is determined by factors such as bone quality, fragment geometry, reduction technique, and implant placement, all of which are critical in ensuring post-operative stability and successful outcomes. Advanced fixation techniques like intramedullary devices have shown potential in managing these fractures but also present unique challenges and risks, such as screw migration and mechanical complications.¹³

Recognizing the unique challenges posed by coronal plane fractures is essential for orthopedic surgeons. Tailoring surgical technique, employing advanced reduction techniques, and carefully selecting fixation devices based on fracture characteristics are key to optimizing outcomes.

This study supports the need for CT scan preoperatively to recognize the coronal plane fracture, especially in AO/OTA 31A2 and A3, which mostly presented in more than 90% of the coronal plane fracture group, and in elderly patients.

Limitations

First, a substantial number of patients were excluded due to the absence of preoperative CT scans and incomplete follow-up data. In routine clinical practice, patients with relatively simple fracture configurations were often evaluated using plain radiographs alone and therefore did not undergo preoperative CT imaging. This selection process may have introduced

selection bias toward more complex fracture patterns. In addition, some patients, particularly foreign nationals, were transferred back to their home countries after surgery, resulting in incomplete long-term follow-up data.

Second, several surgeons performed the operations; therefore, management decisions, such as the use of preoperative CT and implant selection, might differ, and outcomes may also vary according to each surgeon's experience.

Third, because this is a retrospective review, some data, such as clinical outcomes, may not have been completely recorded.

Finally, for an accurate measurement of the shortening parameter, we need radiographic imaging of both sides, and many of our cases presented just one side radiograph, so we could not measure this parameter accurately. Future study should focus on a larger number of patients with more comprehensive preoperative imaging to identify the presence of a coronal plane fracture and its impact on long-term functional outcomes.

Conclusion

Presence of coronal plane fracture in intertrochanteric fractures does not affect the union time and complication rates. Most important factors for optimal outcome remain the good quality of reduction and fixation in both AP and lateral planes. Careful radiograph analysis and good preoperative planning will address any unstable fracture patterns. A stepwise surgical approach for intertrochanteric fixation is the key to optimal fixation stability.

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