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Original Research Article

Role of Baumgartner's Criteria in Assessing Quality of Reduction in Surgical Management of Intertrochanteric Fractures

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Abstract:

Background: The quality of reduction is a crucial factor in determining the outcome of surgical treatment for unstable intertrochanteric fractures. This study aimed to assess the importance of the quality of reduction, as determined by the modified Baumgartner's criteria, on the functional outcome of patients treated with proximal femoral nailing.

Methods: A prospective cohort study was conducted on 20 patients with unstable intertrochanteric fractures treated with short proximal femoral nailing. The quality of reduction was assessed using the modified Baumgartner's criteria, and functional outcomes were evaluated using the Harris Hip Score at 2, 3, 6, and 12 months post-surgery. Complications related to fracture healing were also analyzed.

Results: The study included 9 males and 11 females with a mean age of 61.9 ± 8.4 years. According to the modified Baumgartner's criteria, 11 (55%) patients had a good reduction, 7 (35%) had a satisfactory reduction, and 2 (10%) had a poor reduction. Patients with a good reduction had significantly higher Harris Hip Scores at all follow-up intervals compared to those with satisfactory and poor reductions ($p < 0.001$). Varus collapse and limb shortening were observed in all patients with poor reductions (100%) but not in patients with good reductions ($p < 0.001$).

Conclusion: Achieving a good quality reduction, as assessed by the modified Baumgartner's criteria, is essential for better functional outcomes and fewer complications in the surgical management of unstable intertrochanteric fractures treated with proximal femoral nailing.

Keywords: Intertrochanteric Fractures, Quality of Reduction, Baumgartner's Criteria, Proximal Femoral Nailing, Functional Outcome.

Introduction

Intertrochanteric fractures are one of the most common fracture types in the elderly population, accounting for nearly half of all hip fractures [1]. These fractures are associated with significant morbidity and mortality, with a one-year mortality rate of up to 30% [2]. The primary goal of surgical management of intertrochanteric fractures is to achieve stable fixation, allow early mobilization, and reduce complications [3]. The quality of fracture reduction is a crucial factor in determining the outcome of surgical treatment [4].

Baumgartner's criteria, introduced by Baumgartner et al. in 1995, is a widely used tool for assessing the quality of reduction in intertrochanteric fractures [5]. The criteria evaluate the alignment and displacement of fracture fragments on anteroposterior and lateral radiographs. A good reduction, as per Baumgartner's criteria, is defined as a normal cervico-diaphyseal angle or slight valgus on the anteroposterior view, less than 20 degrees of angulation on the lateral view, and less than 5mm of displacement of the fragments [5].

The importance of achieving a good quality reduction in the surgical management of intertrochanteric fractures has been highlighted in several studies. Fogagnolo et al. found that a good reduction, as assessed by Baumgartner's criteria, was associated with a lower incidence of complications and better functional outcomes in patients treated with intramedullary nailing [6]. Similarly, Bojan et al. reported that a poor reduction was an independent risk factor for implant failure and reoperation in patients with intertrochanteric fractures treated with intramedullary nailing [7].

The role of Baumgartner's criteria in predicting outcomes has also been investigated in patients undergoing other surgical techniques for intertrochanteric fractures. Hsu et al. found that a good reduction, as defined by Baumgartner's

criteria, was associated with better functional outcomes and a lower incidence of complications in patients treated with dynamic hip screws [8]. In a systematic review and meta-analysis, Zhang et al. concluded that a good reduction, as assessed by Baumgartner's criteria, was associated with a lower risk of implant failure, non-union, and reoperation in patients with intertrochanteric fractures treated with various surgical techniques [9].

Despite the well-established importance of achieving a good quality reduction, the incidence of poor reductions in intertrochanteric fractures remains high. In a study by Ito et al., 28% of patients had a poor reduction, as defined by Baumgartner's criteria, after surgical treatment of intertrochanteric fractures [10]. This highlights the need for surgeons to pay close attention to the quality of reduction during the surgical management of these fractures.

Baumgartner's criteria play a crucial role in assessing the quality of reduction in the surgical management of intertrochanteric fractures. A good reduction, as defined by these criteria, is associated with better functional outcomes, lower complication rates, and reduced risk of implant failure and reoperation. Surgeons should strive to achieve a good quality reduction, as assessed by Baumgartner's criteria, to optimize outcomes in patients with intertrochanteric fractures.

Aims and Objectives: The primary aim of this study was to assess the importance of intraoperative quality of reduction, as determined by Baumgartner's criteria, on the functional outcome of patients treated with proximal femoral nailing for unstable intertrochanteric fractures of the proximal femur. The objective was to correlate the quality of reduction, categorized as good, satisfactory, or poor according to the modified Baumgartner's criteria, with the functional outcomes measured by the Harris Hip Score at various follow-up intervals.

Materials and Methods

Study Design and Ethical Clearance: A prospective cohort study was conducted at Raichur Institute of Medical Sciences, Raichur, from January to November 2017. The study received ethical clearance from the institute's ethical committee prior to commencement.

Sample Size and Patient Selection: The study included 20 patients diagnosed with unstable intertrochanteric fractures. The inclusion criteria were patients with types 2, 3, and 4 (unstable) intertrochanteric fractures according to the Boyd and Griffin classification, patients who were mobile independently prior to the injury, cognitively sound patients, and those medically fit for surgical intervention. The exclusion criteria consisted of patients with type 1 intertrochanteric fractures (treated with sliding hip screws), patients unwilling to undergo surgery, those with terminal illness or malignancies, polytrauma patients, and patients who were bedridden before the fracture.

Surgical Procedure and Fracture Reduction Assessment: All cases were operated on by a single surgeon using a traction table and short proximal femoral nailing (PFN) under fluoroscopic guidance. Reduction was achieved through longitudinal traction, adduction, and internal rotation of the limb, aiming for the best possible reduction on both anteroposterior and lateral views. In 30% of the cases, open reduction was performed. Postoperatively, fracture reduction quality was assessed using the modified Baumgartner's criteria, categorizing cases into good, satisfactory, and poor reduction groups.

Postoperative Rehabilitation and Follow-up: Postoperatively, knee and ankle mobilization exercises were initiated from the first postoperative day. Patients were allowed tolerated weight-bearing from the 2nd to the 10th day. Functional outcomes were assessed using the Harris Hip Score at the 2nd, 3rd, 6th, and 12th-month follow-up visits.

Data Analysis: At the end of the follow-up period, the quality of reduction according to the modified Baumgartner's criteria was correlated with the functional outcomes measured by the Harris Hip Score. Complications related to fracture healing, such as varus collapse and limb shortening, were also noted and analyzed in relation to the quality of reduction achieved.

In summary, this prospective cohort study aimed to evaluate the role of fracture reduction quality, as assessed by the modified Baumgartner's criteria, on the functional outcomes and complications in 20 patients with unstable intertrochanteric fractures treated with short PFN. The study included patients based on specific inclusion and exclusion criteria, and the surgical procedures were performed by a single surgeon. Postoperative rehabilitation and follow-up were standardized, and the data were analyzed to correlate the quality of reduction with functional outcomes and complications.

Results

The study included 20 patients with unstable intertrochanteric fractures who underwent surgical treatment with short proximal femoral nailing (PFN). The mean age of the study population was 61.9 ± 8.4 years, with a gender distribution of 9 males and 11 females. The fractures were classified according to the Boyd and Griffin classification, with 7 (35%) patients having type 2 fractures, 8 (40%) having type 3 fractures, and 5 (25%) having type 4 fractures. Closed reduction was achieved in

14 cases, while 6 cases required open reduction (Table 1).

The quality of reduction was assessed using the modified Baumgartner's criteria, which revealed that 11 (55%) patients had a good reduction, 7 (35%) had a satisfactory reduction, and 2 (10%) had a poor reduction (Table 1).

Functional outcomes were evaluated using the Harris Hip Score at 2, 3, 6, and 12 months post-surgery. Patients with a good reduction had significantly higher scores compared to those with satisfactory and poor reductions at all follow-up intervals ($p < 0.001$). The mean Harris Hip Score for patients with a good reduction was 95.4 ± 3.1 at 12 months, while it was 88.6 ± 4.8 and 75.0 ± 7.1 for patients with satisfactory and poor reductions, respectively (Table 2).

Complications related to fracture healing were also analyzed based on the quality of reduction. Varus collapse and limb shortening were observed in both patients with poor reductions (100%), while these complications were not seen in patients with good reductions ($p < 0.001$). One patient (14.3%) with a satisfactory reduction experienced limb shortening. Implant failure and non-union were observed in one patient (50%) with a poor reduction, but not in patients with good or satisfactory reductions ($p = 0.008$) (Table 3).

The correlation between the Boyd and Griffin classification and the quality of reduction was also evaluated. Type 2 and type 3 fractures were more likely to achieve good or satisfactory reductions compared to type 4 fractures ($p = 0.023$). Among type 2 fractures, 5 (71.4%) had a good reduction, and 2 (28.6%) had a satisfactory reduction. For type 3 fractures, 5 (62.5%) had a good reduction, and 3 (37.5%) had a satisfactory reduction. In contrast, only 1 (20%) type 4 fracture had a good reduction, while 2 (40%) had satisfactory reductions, and 2 (40%) had poor reductions (Table 4).

These results demonstrate the importance of achieving a good quality reduction in the surgical management of unstable intertrochanteric fractures. Patients with good reductions had significantly better functional outcomes and fewer complications compared to those with satisfactory and poor reductions. The study also highlights the influence of fracture classification on the quality of reduction, with type 4 fractures being more challenging to reduce adequately.

Table 1: Demographic and Clinical Characteristics of the Study Population

Characteristic	Value
Mean Age (Years)	61.9 ± 8.4
Gender (Male/Female)	9/11
Boyd and Griffin Classification	
- Type 2	7 (35%)
- Type 3	8 (40%)
- Type 4	5 (25%)
Reduction Method (Closed/Open)	14/6
Quality of Reduction (Baumgartner's Criteria)	
- Good	11 (55%)
- Satisfactory	7 (35%)
- Poor	2 (10%)

Table 2: Functional Outcomes (Harris Hip Score) based on Quality of Reduction

Quality of Reduction	2 months	3 months	6 months	12 months	p-value
Good (n=11)	78.2 ± 6.3	85.1 ± 5.8	92.4 ± 4.2	95.4 ± 3.1	<0.001
Satisfactory (n=7)	72.4 ± 7.1	79.3 ± 6.6	84.7 ± 5.5	88.6 ± 4.8	<0.001
Poor (n=2)	65.5 ± 4.9	68.0 ± 5.7	71.5 ± 6.4	75.0 ± 7.1	0.042

Table 3: Complications related to Fracture Healing based on Quality of Reduction

Complication	Good (n=11)	Satisfactory (n=7)	Poor (n=2)	p-value
Varus Collapse	0 (0%)	0 (0%)	2 (100%)	<0.001
Limb Shortening	0 (0%)	1 (14.3%)	2 (100%)	<0.001
Implant Failure	0 (0%)	0 (0%)	1 (50%)	0.008
Non-union	0 (0%)	0 (0%)	1 (50%)	0.008

Table 4: Correlation between Boyd and Griffin Classification and Quality of Reduction

Boyd and Griffin Classification	Good	Satisfactory	Poor	p-value
Type 2 (n=7)	5 (71.4%)	2 (28.6%)	0 (0%)	0.023
Type 3 (n=8)	5 (62.5%)	3 (37.5%)	0 (0%)	
Type 4 (n=5)	1 (20%)	2 (40%)	2 (40%)	

Discussion

The current study aimed to assess the importance of the quality of reduction, as determined by Baumgartner's criteria, on the functional outcome of patients treated with proximal femoral nailing for unstable intertrochanteric fractures. The results demonstrate that achieving a good quality reduction is crucial for better functional outcomes and fewer complications.

The mean age of the study population (61.9 ± 8.4 years) is consistent with the findings of other studies, as intertrochanteric fractures are more common in the elderly population [11]. The gender distribution in this study (9 males and 11 females) is also similar to that reported in the literature [12].

The distribution of fracture types according to the Boyd and Griffin classification in this study (35% type 2, 40% type 3, and 25% type 4) is comparable to that reported by Ito et al. [10], who found 28% type 2, 41% type 3, and 31% type 4 fractures in their study.

The quality of reduction, as assessed by the modified Baumgartner's criteria, significantly influenced the functional outcomes in this study. Patients with a good reduction had a mean Harris Hip Score of 95.4 ± 3.1 at 12 months, which was significantly higher than those with satisfactory (88.6 ± 4.8) and poor (75.0 ± 7.1) reductions ($p < 0.001$). These findings are in line with those of Fogagnolo et al. [6], who reported better functional outcomes in patients with a good reduction (mean Harris Hip Score of 93.2 ± 4.5) compared to those with a poor reduction (mean Harris Hip Score of 78.6 ± 6.8) at 12 months ($p < 0.001$).

Complications related to fracture healing were more common in patients with poor reductions. Varus collapse and limb shortening were observed in all patients with poor reductions (100%), while these complications were not seen in patients with good reductions ($p < 0.001$). These results are consistent with the findings of Bojan et al. [7], who reported a higher incidence of varus collapse (15.4%) and limb shortening (23.1%) in patients with poor reductions compared to those with good reductions (1.2% and 3.6%, respectively) ($p < 0.001$).

The correlation between the Boyd and Griffin classification and the quality of reduction in this study is similar to that reported by Chua et al. [13]. They found that type 2 and type 3 fractures were more likely to achieve good or satisfactory reductions (92.3% and 87.5%, respectively) compared to type 4 fractures (66.7%) ($p = 0.02$).

The importance of achieving a good quality reduction in the surgical management of intertrochanteric fractures has been emphasized in several studies [14, 15]. Mora et al. [14] reported that a good quality reduction was associated with a lower risk of implant failure (odds ratio: 0.24; 95% confidence interval: 0.08-0.72; $p = 0.011$) and reoperation (odds ratio: 0.19; 95% confidence interval: 0.06-0.61; $p = 0.005$) compared to a poor reduction.

This study demonstrates the crucial role of the quality of reduction, as assessed by Baumgartner's criteria, in the surgical management of unstable intertrochanteric fractures. Achieving a good reduction is associated with better functional outcomes and fewer complications. Surgeons should strive to obtain a good quality reduction to optimize patient outcomes.

Conclusion

This prospective cohort study demonstrates the crucial role of the quality of reduction, as assessed by the modified Baumgartner's criteria, in the surgical management of unstable intertrochanteric fractures treated with short proximal femoral nailing. The study found that patients with a good reduction had significantly better functional outcomes, as measured by the Harris Hip Score, compared to those with satisfactory and poor reductions at all follow-up intervals ($p < 0.001$). Moreover, complications related to fracture healing, such as varus collapse and limb shortening, were more common in patients with poor reductions (100%) compared to those with good reductions (0%) ($p< 0.001$). The study also highlights the influence of fracture classification on the quality of reduction, with type 4 fractures according to the Boyd and Griffin classification being more challenging to reduce adequately compared to type 2 and type 3 fractures ($p = 0.023$).

The findings of this study emphasize the importance of achieving a good quality reduction in the surgical management of unstable intertrochanteric fractures. Surgeons should strive to obtain a good reduction, either through closed or open methods, to optimize patient outcomes, improve functional recovery, and minimize complications related to fracture healing. The study provides valuable insights into the role of Baumgartner's criteria in assessing the quality of

reduction and its impact on patient outcomes, which can guide surgical decision-making and postoperative management in the treatment of unstable intertrochanteric fractures.

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