

## The Management of Periprosthetic Greater Trochanter Fractures: A Review

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### Abstract

**Introduction:** Despite periprosthetic greater trochanter fractures being a common injury, relatively little has been published specific to their management. This review explores the available evidence, including 6 case series detailing information regarding fracture classification, indications for fixation and fixation methods.

**Materials and Methods:** A literature search of Embase and MEDLINE databases from 1946 to March 2020 was conducted using a broad search strategy to identify all relevant published data.

**Results:** Six level IV studies alongside several case reports were identified and included in this review.

**Conclusions:** Comprehensive guidance based purely on quantitative data is not possible, due to limited published evidence. However, this review collates and summarises the currently available evidence on how and when to treat these injuries, including a treatment algorithm.

**Keywords:** Greater Trochanter Fracture; Periprosthetic; Fixation; Management

### Introduction

Much has been published regarding fixation of the greater trochanter (GT) with regards to primary and revision hip arthroplasty. The majority of these studies concern the reattachment of an osteotomized trochanter in the acute setting [1]. There are also published series dating back 80 years regarding the management of greater trochanter fractures in native hips [2,3].

Fractures of the GT after total hip replacement are relatively common, occurring in 3-5% of patients [4,5]. It is recognised that management of these fractures presents a challenge in terms of timing and method of intervention and, indeed, whether to intervene at all [6]. To the authors' knowledge, there has been no published review

on the available evidence. Our aim is to summarise the published data in order to help inform management of these fractures.

### Materials and Methods

#### Literature Search

To identify all relevant material available relating to the diagnosis, classification and management of periprosthetic GT fractures, a literature search was conducted by the authors independently. The Embase and MEDLINE databases were searched for journal articles and abstracts on this topic from 1946 to March 2020. Only articles available in English were included.

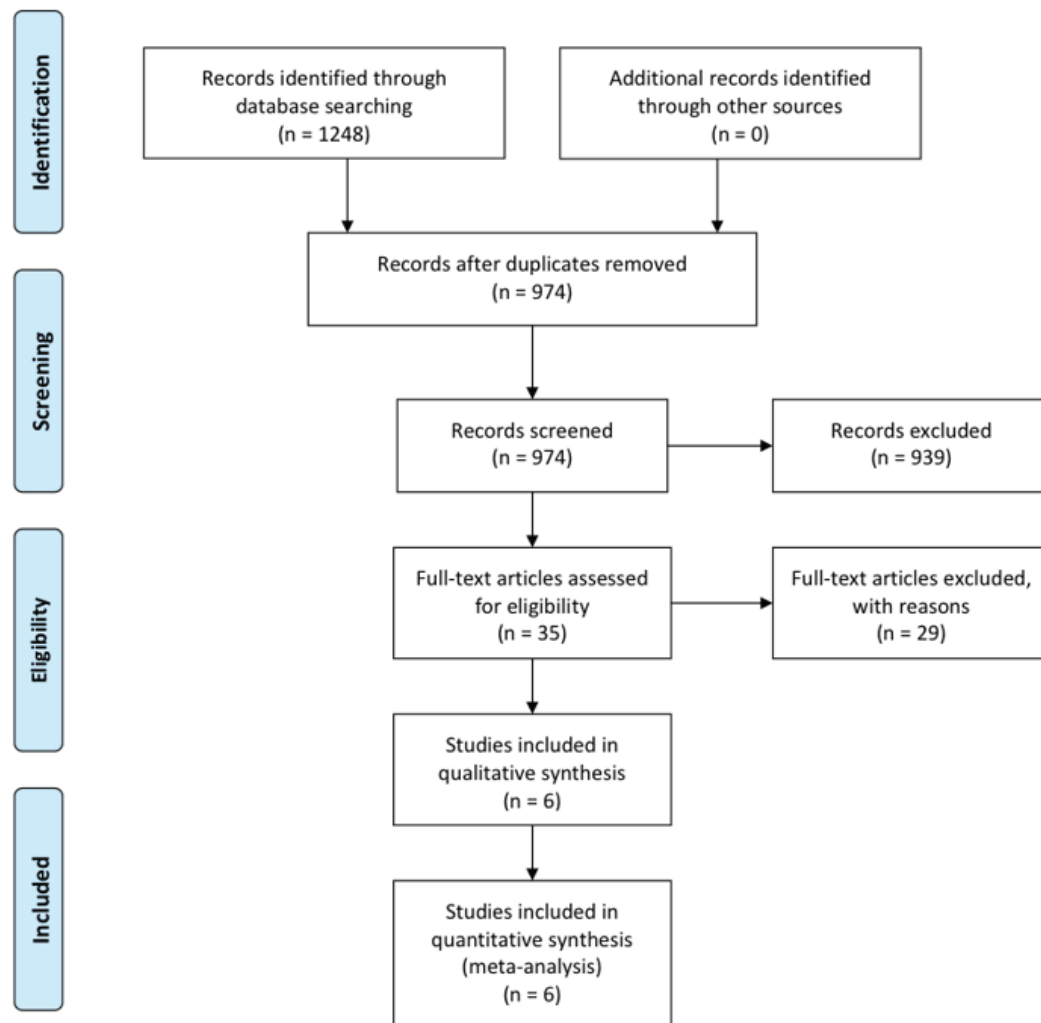
The keywords used were:

1. "greater trochant\*" AND "fractur\*"
2. "fixation\*" OR "treatment\*" OR "manag\*"
3. 1. and 2.

### Eligibility Criteria

Both authors assessed each article based on the titles and abstracts and if eligibility was not clear, the entire article was read. The studies were included for analysis based on the following criteria:

1. The study must involve multiple patients with GT fractures with hemiarthroplasty or total hip replacement in situ
  2. The study must include rationale for the decision made to treat operatively or non-operatively
  3. The study must include outcomes for the selected treatment method
  4. If other periprosthetic fracture types were included in the study, data specific to the GT fractures must be reported
1. The study must be published in English



**Figure 1:** PRISMA flow diagram of literature search strategy and results.

## Results

This produced 974 articles (Figure 1), of which 939 articles were excluded based on titles and abstracts. The full text of the remaining 35 articles were reviewed and the bibliographies of these were then reviewed for relevant citations. 29 of these studies were excluded

as they did not meet the eligibility criteria. The 6 remaining studies were all retrospective case series including data specific to the management of periprosthetic GT fractures [4-9]. The management of 119 periprosthetic GT fractures in total were reviewed (Table 1).

Study	Type of Hip Surgery	Number of GT Fractures	Female %	Mean Age/Range	Mean Follow-up	Osteolysis
Brun & Maansson (2013)	Reverse hybrid THR	26	81	41-86	N/A	N/A
Hendel et al. (2002)	Primary THR (uncemented, cemented and hybrid) or revision	21	100	68 (59-75)	N/A	N/A
Hsieh et al. (2005)	Uncemented THR	23	N/R	51	48 months	All
Pritchett (2001)	Primary THR (uncemented, cemented & hybrid), hemiarthroplasty	30	70	69 (48-84)	40 months	N/A
Stewart et al. (2017)	N/A	8	N/R	N/R	30 months	N/R
Tetreault & McGrory (2016)	Primary and revision THR	11	N/R	N/R	42 months	Some cases

**Table 1:** Case series identified specific to the management of periprosthetic GT fractures (N/R- data not reported).

## Diagnosis

Acute fractures of the greater trochanter typically present with sudden onset lateral hip pain with or without a limp or Trendelenburg lurch [5]. There may be no or only minor trauma preceding the onset of symptoms, with patients often describing a sudden onset on walking or twisting. Up to 60% of patients are asymptomatic [6]. The surgical approach for the initial arthroplasty does not appear to be a risk factor for developing these fractures [4]. These injuries are most commonly diagnosed by plain radiography alone, although if there is a suspicion of extension distally and potential stem instability, computed tomography (CT) may be carried out [10].

## Classification

Brun and Maansson [4] proposed a classification system based on fracture pattern, divided into three groups:

**Type 1:** Fracture of the medial tip of the greater trochanter created at the time of the femoral neck osteotomy

**Type 2:** An avulsion-type fracture of only the medial tip of the greater trochanter

**Type 3:** A complete fracture of the greater trochanter (displaced or undisplaced)

In their study, comparing the patient reported outcomes of these three fracture patterns with data from the Swedish and New Zealand hip registers, no significant changes in all measured values were reported for types 1 and 2. Type 3 fractures, however, produced significantly higher pain scores and lower Oxford Hip Score values than would be expected.

This classification does not consider several potentially significant features of this type of fracture. Pritchett highlighted the importance of fracture displacement in both patient reported outcome and potential to achieve union [6].

The second important feature to take into account is the bone quality of the fragment. Hsieh reported a significant proportion of delayed fractures through osteolytic cysts secondary to polyethylene wear particles [7]. Not only does this have implications for the technique that may be required for fixation of the fracture itself, but also raises questions about whether revision of the prosthesis is required [11].

The final factor to consider is whether instability of the hip joint is an issue. If the fracture leads to dislocation or was caused by a dislocation, the threshold for surgical intervention is significantly lowered [11].

### Indications for Fixation

Historically, isolated GT fractures have been viewed as relatively benign injuries with early case series reporting that healing occurs regardless of treatment, with return to normal function in 2 months [2,3]. It is now more commonly accepted that outcomes can be significantly worsened in the presence of such a fracture [4].

Pritchett recommended fixation based on the following indications [6]:

1. Dislocation or instability of the prosthesis
2. Severe limp or pain
3. Displacement of the trochanter fracture of >2cm (compared with the contralateral hip)

That paper also reported that pain and limping resolved spontaneously in half of symptomatic fractures over a few months. There was not thought to be any adverse consequence in delayed treatment.

Hamadouche proposed a treatment algorithm for management of greater trochanter non-union which incorporated a positive Trendelenburg sign alongside fracture displacement, limp, pain and instability as a key factor when deciding whether fixation is necessary [12].

### Method of Fixation

Multiple techniques for greater trochanter fixation have been described, although most published literature concerns fixation of an osteotomised trochanter, rather than following a fracture. There are several difficulties in directly comparing management options in these two distinct situations as important factors in bone healing may differ including blood supply, soft tissues and potential fibrous interposition [6]. However, due to a lack of evidence relating specifically to the management of periprosthetic greater trochanter fractures, considering fixation options for the greater trochanter in all circumstances is necessary.

Historically, iatrogenic greater trochanter fractures observed intra-operatively have been fixed with mono or multifilament wires alone. In a case series of 15 patients with this complication, Hendel noted a 100% union rate with this method of fixation [5]. However, wire breakage has been reported in up to 20% of cases and catastrophic migration to the popliteal fossa and left side of the heart have been recorded [1].

Cable plating is another option which has been developed through several iterations. The first generation consisted of an H-shaped gripping device which was seated on the greater trochanter attached to several cables that passed medially. The updated second generation incorporated a filament bundle pattern, allowing provisional cable fixation. The current, third, generation is more anatomical and allows more uniform cable compression [13]. Unfortunately, in the setting of greater trochanter fractures, non-union rates as high as 35% have been reported, with cable failure in 29% of cases [8]. The quality of reduction and corresponding bony apposition has been noted as a key factor in the success of this method of fixation.

Locking plates are another described option, although little evidence is available on outcomes following fracture. An in vitro study comparing multifilament wires, cable plates and locking plates did not show any mechanical advantage in terms of compression, distraction loading and failure load tests between cable and locking plates, although both plates were superior to wires alone [14]. As part of a wider case series using this technique, Tetreault reported a union rate of 89% in 9 patients following periprosthetic fracture. The main complication of this technique is ongoing trochanteric pain, in 19% of patients [9].

Finally, in the presence of significant osteolysis, bone grafting together with revision of implants should be considered. In a case series of 19 patients with greater trochanter fracture secondary to osteolysis undergoing revision of implants, morselised femoral head bone graft was used together with monofilament wires [15]. 94% union was reported in this study. Demineralised bone matrix has been shown to be another useful adjunct [16].

Post-operatively, a range of protocols were used ranging from no restrictions of mobility to 6 weeks of non-weight bearing with no active hip abduction.

### Discussion

Currently, there is limited data available to clinicians to aid decision making when confronted with an acute periprosthetic greater trochanter fracture. Published evidence consists of relatively small case series (level 4 evidence), often with limited sample sizes, and only 6 deal exclusively with this clinical problem (Tables 2 and 3). As a result, some extrapolation must be made from the available evidence relating to greater trochanter osteotomies and the fixation of non-unions. Even this data only consists of case series [1] so guidance based purely on quantitative evidence is not possible.

Study	% Treated Non-operatively	Non-union %	Management	Complications
Brun & Maansson (2013)	73	N/A	Bed rest/protected weight bearing 3-4 weeks	Pain or limp in 70% of type 3 fractures
Hendel et al. (2002)	29	33 (associated with dislocation)	2 weeks bed rest	Limp & pain
Hseih et al. (2005)	83	21	Crutch walking/activity restriction	63% revised within 3 years
Pritchett (2001)	70	50	No restrictions	29% of patients had persistent pain and limp
Stewart et al. (2017)	0	N/A	N/R	N/R
Tetreault & McGrory (2016)	0 (all had failed non-op)	N/A	N/R	N/R

**Table 2:** Results for fixation of periprosthetic GT fractures (N/R- data not reported).

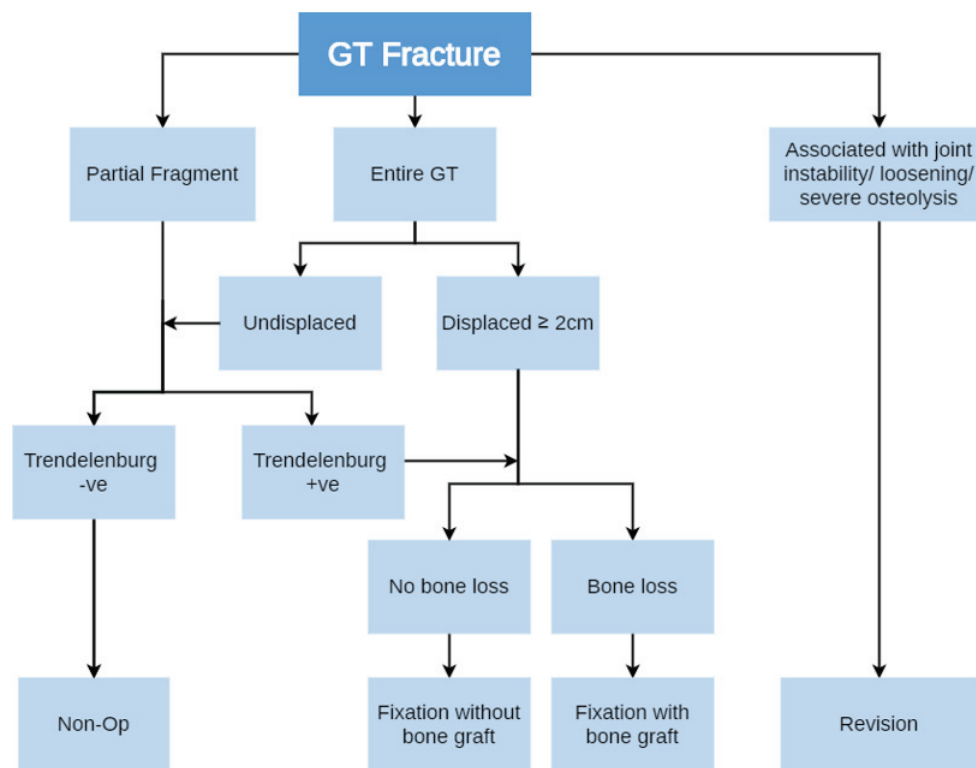
Study	% Fixed	Fixation Method	Non-union %	Post-op Management	Complications
Brun & Maansson (2013)	27	K-wires & cerclage or claw plate	N/A	N/A	N/R
Hendel et al. (2002)	71 (all seen intra-operatively)	Wire fixation	0	N/A	Limp & pain
Hseih et al. (2005)	17	N/A- combined with revision	0	N/A	N/R
Pritchett (2001)	30	Cables/wire/ethi-bond suture	N/A	No restrictions	N/R
Stewart et al. (2017)	100	Cable plate	35%	6 weeks toe- touch/non-weight bearing and no abduction	Implant failure, infection, lateral hip pain
Tetreault & McGrory (2016)	100	Locking plate	9%	Touch weight bearing for 4 weeks then partial weight bearing for 2 weeks, no abduction for 6 weeks	Trochanteric pain, 1 dislocation

**Table 3:** Results for non-operative management of periprosthetic GT fractures (N/R- data not reported).

Based on the available evidence, the authors would recommend management of these injuries according to the algorithm in Figure 2. As with any periprosthetic fracture, consideration must first be given to whether the prosthesis remains viable or whether revision surgery is required. In symptomatic patients, the size of fracture fragment, fragment displacement, bone stock and presence of Trendelenburg's sign should all be taken into account when considering fixation.

## Conclusion

Based on the limited data available in the literature, it is not possible to firmly recommend a specific fixation method but clearly a frank discussion with the patient is required regarding potential benefits and risks of surgery, as well as timing of surgery. Many of these studies have reported high complication rates following surgery and, with so little quantitative data available, the ultimate decision will rely on patient and surgeon preference.



**Figure 2:** Recommended treatment algorithm for periprosthetic greater trochanteric fractures.

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