

## R E V I E W

## Isolated greater trochanter fractures

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**Abstract.** *Introduction:* Isolated fractures of the greater trochanter (GT) in adults are rare injuries and traditionally treated without surgery. The present systematic review was designed to examine the treatment protocol for isolated GT fractures and to discover if innovative surgical techniques, such as arthroscopy or suture anchors, can be used to improve outcomes in young active patients. *Methods:* A systematic review was conducted including all full-text articles suited our inclusion criteria from January 2000 describing treatment protocols of isolated great trochanter fractures confirmed at MRI in adults. *Results:* The searches identified a total of 247 patients from 20 studies with a mean age 56.1 years and mean follow-up 13,7 months. Only 4 case report treated 4 patients with not unique surgical strategy. The rest of the patients were treated conservatively. *Discussion:* Most trochanteric fractures can heal without surgical intervention with good results. However, the patient must not immediately bear full weight and the abductor's function could decrease. Displaced GT fragments more than 2 cm or athletes, young, demanding patients may benefit from surgical fixation to regain abductor function and strength. Evidence-based surgical strategies could be provided by arthroplasty and periprosthetic literature. *Conclusion:* The grade of fracture displacement and the physical demands of the athlete can be important factors in the decision process for or against surgery. By now, no evidence-based guideline exists for the ideal treatment method in demanding patients. It is necessary use a "patient-specific" treatment strategy. ([www.actabiomedica.it](http://www.actabiomedica.it)).

### Introduction

Isolated fractures of the greater trochanter (GT) are unusual injuries and less studied than common hip fractures. Recent literature has mainly focused on the importance of fully evaluate the extension of the injury (1). Magnetic Resonance Imaging (MRI) is recommended to identify occult intertrochanteric extension which can lead to a different treatment due to the risk of displacement (2,3). If MRI confirmed an isolated fracture without intertrochanteric extension, there are not clearly defined surgical indications because of the lack of evidence in the topic.

Although isolated GT fractures are traditionally managed conservatively with a week of bed rest or early partial weight bearing with crutches, in the recent literature some authors begin to suggest surgical approach in young, active patients with large, displaced GT fragments who may benefit from surgical fixation due to the risk of abductor impairment (4).

The present systematic review of the literature was designed to examine the recent recommendation for isolated GT fractures and if possible, to answer the following questions: 1. Which is the treatment protocol for GT fractures confirmed isolated at MRI? 2. Can innovative surgical techniques, such as arthroscopy or

suture anchors, be used to improve outcomes in young active patients?

## Methods

During September 2022 we performed searches of PubMed, EMBASE, Scopus and Cochrane systematic reviews by using the search terms “greater trochanter”, “hip”, “fracture”, “avulsion”, “hip abductor tendon”. We followed the 27-items checklist PRISMA Statement 2020 (5) to plan and conduct our review to ensure the correct methodology of the study.

The inclusion criteria were as follows: articles from January 2000, English-written articles in humans, full text available, both retrospective and prospective series, case report and articles describing treatment protocols of isolated great trochanter fractures confirmed at MRI.

The exclusion criteria were as follows: studied describing isolated GT fractured diagnosed using only x-ray and not confirmed at MRI, fractures associated with other occult fractures of the hip including acetabulum, paediatric fractures, not written in English, full-text not available.

Case reports were included in our study and we did not limit the number of patients in each study or the minimum duration follow-up because of limited evidence available.

The first search yielded a total of 311 articles reduced at 109 after applying the “English” and “from year 2000” filters. We began the study selection by screening titles and abstracts of articles retrieved from the search. For articles identified to be potentially relevant, the full text was then reviewed. The full text was also reviewed if a decision could not be made from reading the title and abstract alone. By title and abstract reading of these 109 articles, 40 full-text articles were assessed for eligibility. We excluded 18 articles as they did not fulfil our inclusion criteria. In addition, we manually screened citations of relevant articles to identify additional studies and we identified 2 additional articles from bibliography. We performed a new search without “Mesh” terms to include latest published articles not yet indexed and we added 1 relevant study.

If uncertainty existed about inclusion, the criteria was discussed among the authors and a final decision was made by consensus. Data was extracted into Microsoft Excel: year and country of study, patients demographic included age and gender, type of fracture confirmed at MRI, management of fracture, outcomes following surgery, follow-up period.

The literature search strategy is summarized in Figure 1.

## Results

Our literature searches identified a total of 247 patients from 20 studies suited the inclusion criteria published from 2000 to 2022. (Figure 1: PRISMA Flow Chart). Most of the reports were observational studies (Case series n= 15). One systematic review and four case report were included in the study.

Complete data were not available in some of the studies but information such as age, diagnosis, management of fracture and follow up was identified in all reports.

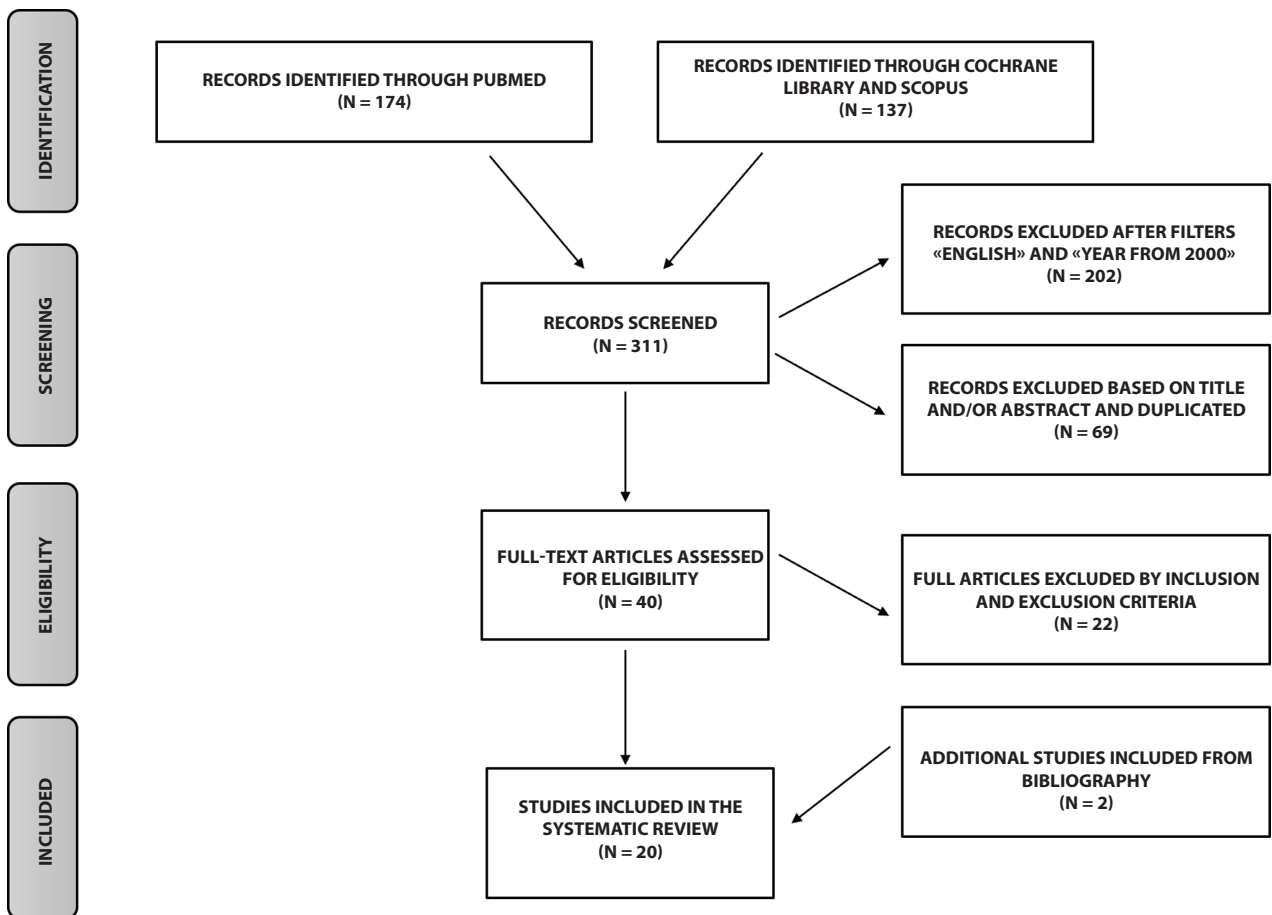
The mean age of the patients was 56.1 years and the minimum follow-up period was 3 months (range 3-36, mean follow-up 13,75 months). All 247 patients were diagnosed used MRI. A summary of the articles included and detailed demographic data has been provided in Table 1.

In 16 studies 243 patients were treated conservatively with similar programme and only 4 case report treated 4 patients with different surgical strategy. A summary of the different types of treatment methods applied is included in Table 2.

Healed Outcome was defined as no pain at the last follow-up and a return to normal walking and usual activities without any complaints. All studies declared a final healed outcome with their treatment strategy and no one reported complications.

## Discussion

Isolated fractures of the greater trochanter, classified by AO/OTA as 31A1.1, are not considered fragility fractures like conventional hip fractures of the



**Figure 1.** PRISMA Flowchart for the Systematic Review studies selection.

elderly (6). Indeed, they are less frequent injuries that may occur after direct high energy trauma but more often are caused by forced muscle contraction of the hip abductors and external rotators, usually due to physical activity instead of falls, in a more active and young population (7). According to Yang et al (8) these fractures can also occur during the closed reduction of obturator type dislocation of the hip joint by avulsion force.

Patients with greater trochanter fracture are typically younger (in our study the average age was 56.1) and experiences pain and difficulty in walking, although weight bearing is usually possible. The greater trochanter is a complex attachment sites for important muscles which include abductors such as gluteus medius. During normal gait, the gluteus medius and minimus muscles are major hip abductors, stabilizing the pelvis on the weight-bearing leg. Avulsion in

the abductor's muscle can lead to pain and a loss of strength, may cause a reduced range of motion and muscle strength during the abduction (9). The abductor muscle insertion may pull the greater trochanter fragment proximally. If this is not reduced and fixed, the abductor muscle will be shortened and its function impaired (4).

Sanderson et al (10) observed a marked difference between ranges of abduction on affected and unaffected sides of the hip joint within 6 months of conservative treatment for the fracture and at 1 year the strength of abduction remained significantly lower than that of the unaffected hip. Furthermore, abduction strength of the hip joint may be reduced as a result of the conservative treatment.

Despite this, in our review 80% of reports propose a conservative approach for this type of fracture (a total of 98% of patients). Different methods

**Table 1.** Summary of studies reporting series on Isolated Greater Trochanteric Fractures with demographic data, treatment strategy and follow-up (abbreviations NA= Not Available).

Author	Journal	Year	Study Design	N. of patients	Age (range)	Mean age	Conservative	Surgery	Follow-up (months)
1. <i>Omura (22)</i>	Arch Orthop Trauma Surg	2000	Case Series	1	62-101	79.2	1	0	3
2. <i>Craig (23)</i>	Skeletal Radiology	2000	Case Series	3	24-90	56	3	0	3
3. <i>Feldman (24)</i>	AJR Am J Roentgenol	2004	Case Series	2	50-95	NA	2	0	3
4. <i>Lee (25)</i>	Arch Orthop Trauma Surg	2010	Case Series	5	65-85	72.8	5	0	4
5. <i>Lalonde (11)</i>	Iowa Orthop J.	2010	Case Series	10	59-90	79	10	0	15
6. <i>Wong (26)</i>	Hong Kong J Radiol	2013	Case Series	41	NA	79.2	41	0	18
7. <i>Kambali (12)</i>	J Orthop Allied Sci	2013	Case Report	2	48	48	1	1	6
8. <i>Yang (8)</i>	Hip & Pelvis	2014	Case Report	1	47	47	0	1	24
9. <i>Kim et al (27)</i>	Yonsei Medical Journal	2015	Case Series	6	25-65	40	6	0	3
10. <i>Kim SJ (1)</i>	BMC Musculoskelet Disorders	2015	Review	11	NA	74.3	11	0	NA
11. <i>Chung (28)</i>	Hip & Pelvis	2016	Case series	10	52-91	76.2	10	0	3
12. <i>Arshad (2)</i>	International Journal of the Care of the Injured	2017	Case series	35	NA	76	35	0	NA
13. <i>Park (3)</i>	International Journal of the Care of the Injured	2018	Case series	23	37-89	77.1	23	0	6
14. <i>Moon (29)</i>	BMC Musculoskelet Disorders	2018	Case series	9	65-91	77	9	0	36
15. <i>Ren (4)</i>	BMC Musculoskelet Disorders	2018	Case Series	7	NA	74.7	7	0	12
16. <i>Nob (30)</i>	Hip & Pelvis	2019	Case series	10	34-94	66.3	10	0	NA
17. <i>Busato (14)</i>	The Journal of Bone and Joint Surgery	2020	Case Report	1	25	25	0	1	24
18. <i>Walsh (21)</i>	Skeletal Radiology	2021	Case series	19	33-102	NA	19	0	NA
19. <i>Prommik (7)</i>	BMC Musculoskelet Disord	2022	Case series	50	65-87	78	50	0	36

Author	Journal	Year	Study Design	N. of patients	Age (range)	Mean age	Conservative	Surgery	Follow-up (months)
20. Sanderson (10)	Journal of the AAOS Global Research & Reviews	2022	Case report	1	35	35	0	1	24
				N. of patients		Mean age	Conservative	Surgery	Follow-up (months)
				<i>Total</i>	247	56,1	243	4	13,75

**Table 2.** Summary of the different types of treatment methods.

Author	Year	Number patients	Treatment	Follow-up (months)	Result
1. Omura	2000	1	Conservative: 1 week of bed rest then gradual full weight-bearing with crutches or a walker	1	Healed
2. Ctaig	2000	3	Conservative: not specified	3	Healed
3. Feldman	2004	2	Conservative: not specified	3	Healed
4. Lee	2010	5	Conservative: 1 week of bed rest then gradual full weight-bearing with crutches or a walker	4	Healed
5. Lalonde	2010	10	Conservative: immediate weight-bearing	15	Healed
6. Wong	2013	41	Conservative: not specified	18	Healed
9. Kim et al	2015	6	Conservative: skin traction for 2 weeks	1	Healed
10. Kim SJ	2015	11	Conservative: not specified	NA	Healed
11. Chung	2016	10	Conservative: bed rest until pain relief then gradual full weight-bearing with crutches or a walker	3	Healed
12. Arshad	2017	35	Conservative: not specified	NA	NA
13. Park	2018	23	Conservative: full weight-bearing permitted after 4–6 weeks	6	Healed
14. Moon	2018	9	Conservative: 1–3 weeks of bed rest followed by progressive walker-assisted ambulation	36	Healed
15. Ren	2018	7	Conservative: immediate weight-bearing	12	Healed
16. Nob	2019	10	Conservative: 1–3 weeks of bed rest with skin traction then gradual weight-bearing	NA	NA
18. Walsh	2021	19	Conservative: not specified	NA	NA
19. Prommik	2022	50	Conservative: not specified	36	Healed
7. Kambali	2013	2	Isolated bilater greater trochanteric both displaced and comminuted but only the left hip was symptomatic: right hip conservative with skin traction, left symptomatic hip surgery: <b>tension band wiring</b>	6	Healed
8. Yang	2014	1	<b>Surgery:</b> fixed with <b>2 cannulated screws</b> with washers	24	Healed
17. Busato	2020	1	<b>Surgery</b> <b>3 anchors</b> 5.0 mm titanium	24	Healed
20. Sanderson	2022	1	<b>Surgery</b> combining <b>3 different methods of fixation:</b> 1. osteosynthesis with screws and washers, 2. suture anchor and a 3. knotless double-row suture bridge tension band construct	24	Healed

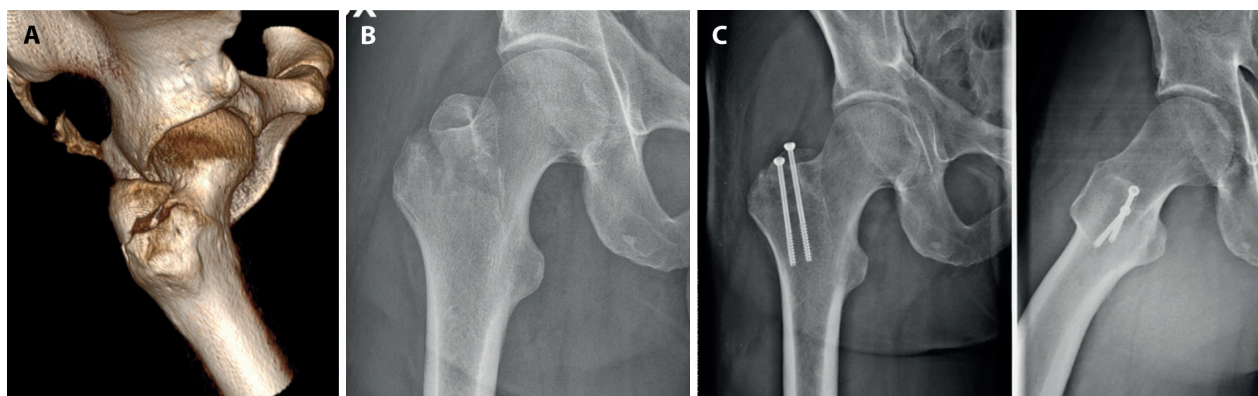
of treatment were found with no guidelines regarding treatment protocols. Non-operative treatment consisting of analgesics, limited activities, bed rest for 1-3 weeks with use of skin traction in some cases, followed by full weight bear mobilisation with good outcome recorded on follow-up. Lalonde et al. (11) allowing their patients to immediately full weight bear with the aid of analgesia and support. These results reported good outcomes on routine follow-up with no pain and normal walking.

Only 4 recent case reports begin to treat these lesions with innovative minimally invasive methods. All these 4 patients were younger than 50-year-old (a mean age of 38 years) and athletic. Kambali et al (12) used a tension band wiring like described in AO/OTA references (13). Yang et al. (8) used two cannulated screw. Busato (14) and Sanderson (10) in their most recent records applied innovative strategies such as suture anchor and knotless double-row suture. In particular Sanderson suggest referring at arthroplasty and periprosthetic literature. In addition, to share our experience we report two surgical treated cases. A 41-year-old man presented to our Emergency Department with pain in the right hip after a bicycle trauma. Pelvis radiographs showed an isolated great trochanter fracture confirmed by RMI and TC (Figure 2A). We attempted a conservative treatment but at 7 days control radiography demonstrated a fragment displacement so we proposed surgical treatment (Figure 2B). Guided by image intensifier, the fixation was performed through two 3.5 cannulated partially threaded screws.

The patient was mobilised immediately after surgery and at three months clinical examination revealed pain-free hip movement and deambulation with a stable alignment of the fragment at the hip radiograph (Figure 2C). Then another 41-year-old man arrived at our hospital after high-energy direct left hip trauma as a result of high-speed motorbike accident. Pelvis radiograph showed an isolated great trochanter fracture confirmed at RMI (Figure 3A-B). Considering the significant displacement of the greater trochanter, surgical treatment was preferred. Guided by image intensifier, the fixation was performed through a tension band wiring (Figure 3B). At 3 months the patient was clinically and radiographically healed. In both case we got excellent short-term results, we will follow-up our patients to evaluated also long-term results.

Most trochanteric fractures can heal without surgical intervention if the displacement is less than 1 cm. However, the patient must not bear weight on the affected leg for up to a month. Many patients may take up to 3 months to return to normal physical activity (15). Some authors (1,6,15) and AO reference (13) propose a surgery treatment with a >2 cm fracture displacement in young and athletics patients. Surgical treatment of gluteus medius tendinous injuries at the GT anatomical insertion site has been well described with a variety of open and endoscopic options with double-row suture anchor fixation (9,16,17).

To aid in surgical decision, the arthroplasty literature, greater trochanteric osteotomies and periprosthetic GT fractures provide indication for treatment strategies.



**Figure 2.** 41-year-old man - bicycle accident (a) TC of the right hip at the time of presentation confirmed at isolated great trochanter fracture, (b) after 7 days revealed a proximally fragment displacement, (c) at 90 days after fixation through two 3.5 cannulated partially threaded screws.



**Figure 3.** 41-year-old man – motorbike accident (a-b) Pelvis radiograph showed an isolated great trochanter fracture confirmed at RMI (c) Guided by image intensifier, the fixation was performed through a tension band wiring.

In this literature is stated that notable improvement in function was only achieved with the osseous union (18). These findings give evidence in favor of surgical treatment with the goal of anatomic GT fracture reduction to avoid nonunion which can lead to pain in the trochanteric region, functional gait abnormality, and reduced hip abductor strength. Biomechanical studies found that the cable grip system provided strongest fixation (19,20). Also various tendon repair techniques and sports literature can suggest innovative surgery strategies with the use of double-row all-knotless repair and suture anchor which provides increased strength and increased healing potential (9,17,21).

By now, no evidence-based guideline exists for the ideal treatment method. The common goal is the restoration of everyday occupational and private activities to regain the quality of life. Hence the importance of choosing a “patient-specific” treatment strategy following evidence-based technique when treating uncommon fractures.

## Conclusion

- MRI is mandatory to diagnose a true isolated greater trochanter fracture without intertrochanteric extension.
- Nonoperative treatment consisting of analgesics, limited activities, bed rest for 1-3 weeks

with use of skin traction in some cases, followed by full weight bear mobilisation with good outcome recorded on follow-up

- Displaced GT fragments more than 2 cm or athletes, young, demanding patients may benefit from surgical fixation to regain abductor function and strength.
- To aid in surgical decision, the arthroplasty literature, greater trochanteric osteotomies and periprosthetic GT fractures provide indication for treatment strategies
- The Grade of fracture displacement and the physical demands of the athlete can be important factors in the decision process for or against surgery. By now, no evidence-based guideline exists for the ideal treatment method in demanding patients. It is necessary use a “patient-specific” treatment strategy. Comparative studies are required to refine criteria for surgery.

**Ethical Approval:** This retrospective study received a waiver from the local committee (Comitato etico Città della Salute e della Scienza di Torino 2018/20121).

**Authors Contributions:** Alessandro Aprato and Alessandro Massè planned and designed the study and analyzed the data and gave interpretation of the results, Alessandra Cipolla collected data and

wrote the manuscript, Luigi Branca Vergano and Federico Bove reviewed the manuscript and made the literature review.

**Availability of Data and Materials:** All data have been store in the dedicated repository of University of Turin.

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**Conflicts of Interest:** Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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