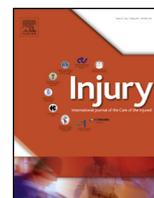




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## Nail or plate fixation for A3 trochanteric hip fractures: A systematic review of randomised controlled trials

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### ABSTRACT

Continuing controversy exists for the choice of implant for treating A3 trochanteric hip fractures so we undertook a systematic review of randomised controlled trials from the year 2000 onwards that have compared an intramedullary nail with an extramedullary fixation implant for the treatment of these fractures. Data on the occurrence of any fracture healing complications was extracted and the results combined to calculate Peto odd ratio. Nine studies involving 370 fractures were identified. Three studies involving 105 fractures compared an intramedullary nail with a static fixation (condylar, blade or locking plate). Plate fixation was associated with a fivefold increase risk of fracture healing complications (19/52 (36.6%) versus 4/53 (7.5%), odds ratio 0.14, 95% Confidence intervals 0.04–0.45). Six studies involving 265 fractures compared an intramedullary nail with a sliding hip screw. No statistically significant difference was found in the occurrence of fracture healing complications between implants (13/137 (9.5%) versus 11/128 (8.6%) odds ratio 0.28, 95% Confidence intervals 0.50–2.80). Based on the evidence to date from randomised trials, the use of fixed nail plates for surgical fixation of this type of fracture cannot be justified. Intramedullary nail fixation and the sliding hip screw have comparable fracture healing complication rates.

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### Introduction

Trochanteric fractures at the level of the lesser trochanter of the femur include the fracture patterns of transverse, reversed and comminuted fractures. These are classified as A3 fractures in the Orthopaedic Trauma Association and AO classification system [1]. This fracture configuration presents significant challenges in their surgical fixation due to the medial displacement of the femur. This occurs as a consequence of the loss of lateral femur cortical bone support. Increased degrees of femoral medialization have been shown to be associated with a progressive increase in the risk of fixation failure [2–5]. Previous studies have highlighted the potentially high fixation failure rate for this type of fracture, regardless of the type of implant used [6,7].

Static or fixed angle nail plate fixation has been suggested as a method of treating this fracture [7]. Static implants include the 95° blade plate, condylar plate and the more recently developed

femoral reconstruction locking plate. These implants fix the fracture solidly, with no capacity for sliding of the construct or femoral medialization. The traditional sliding hip screw (SHS) has a 135° angle between the plate and lag screw and sliding and collapse may occur at the fracture site. For the A3 fractures this may lead to medial displacement of the femur with excessive consumption of the lag screw slide [4,5]. In theory an intramedullary nail may resist femoral medialization as the proximal portion of the nail will impact against the proximal femur [3]. This has led some reviews to suggest that this fracture type should be treated with an intramedullary implant [8–10].

The trend to the increased use of intramedullary fixation has been supported by biomechanical studies that are frequently quoted to favour intramedullary nail fixation [11–14]. Unfortunately these theoretical and biomechanical studies do not necessarily predict what happens in vivo. Early designs of these intramedullary nails were associated with an increased risk of fracture healing complications compared to the SHS but the more contemporary designs now produce comparable outcomes to that of the sliding hip screw for trochanteric hip fractures [15].

To date there has been very limited supporting evidence for these different treatment methods from clinical studies for A3 fractures. This is because this fracture pattern is uncommon and

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the treatment has to be undertaken in the emergency situation. Case series reports provide only limited value due to the selection of cases and the variation in surgical techniques. Randomised trials enable a more robust method of evaluating the different implants. We have therefore undertaken a systematic review of contemporary randomised trials that have compared different methods of surgical fixation for A3 trochanteric hip fracture.

## Patients and methods

We undertook the literature review using the search strategies for the Cochrane library review on nails versus sliding hip screw for extracapsular hip fractures [15,16]. This included searches of the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register, the Cochrane Central Register of Controlled Trials, MEDLINE (2000 week 1 to March week 1 2017) and EMBASE (2000 week 1 to 2017 Week 1) [15]. No language or publication restrictions were applied. All randomised controlled trials comparing an extramedullary fixation implant with an intramedullary nail for A3 fractures were assessed for inclusion in the review. Data was extracted independently by two reviewers and differences resolved by discussion. Additional information was sought from authors of any study that was reported to include A3 fractures without providing separate data for this fracture type.

Fracture healing complications were defined as cut-out of the implant (including central penetration of the lag screw), non-union of the fracture, later avascular necrosis of the femoral head, plate detachment from the femur, re-fracture around the implant (excluding fractures of the femur that do not involve the site of the implant and those that occurred during surgery), breakage of the implant, any other major complications needing significant revision surgery. Patients with more than one of the above complications were only counted once. We excluded minor complications such as removal or change of the screw, dynamization of the implant and attention to wound healing complications.

Data extracted from the studies was summarized in forest plots to calculate the Peto odds ratio (OR) and 95% confidence interval (CI). All meta-analysis and graphing was using RevMan (version 5.3; The Cochrane Collaboration, Copenhagen, Denmark). Heterogeneity of the studies was estimated by calculating both the  $I^2$  statistic and the chi-squared test of heterogeneity. An  $I^2$  value of more than 50% was considered indicative of heterogeneity. Individual study results were combined using the Mantel-Haenszel method using a fixed effects model assuming the  $I^2$  statistic was less than 50%. A random effects model would have been used if the  $I^2$  statistic was more than 50%.

## Results

Fig. 1 details the studies that were identified and those that were excluded and included within the review. Twenty-four studies were excluded [18–42]. Data from nine studies were included. Three of these studies were for fixed nail plates and the remainder were for the sliding hip screw. Five different type of intramedullary nail were used. For the study of Haq [44], this study included some A2 fractures with loss of the lateral wall so they acted as A3 fractures with femoral medialisation. Table 1 gives the characteristics of the included studies. The methodology assessment of the studies was using that of the Cochrane collaboration with one point allocated for six trial features of random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment for pain and function, incomplete outcome data and free of selective reporting [15].

Fig. 2 summarises the results split for either the fixed nail plates or the sliding hip screw. For the three studies of static implants involving 105 participants, 4 of the 53 nail fixation patients had fracture healing complications (7.5%) against 19 of the 52 plate fixations (36.6%). This difference was statistically significant (odds ratio 0.14, 95% Confidence intervals 0.04–0.45). For the comparison of nail versus the SHS, six studies involving 265 fractures were identified. 13 of the 137 nail fixations had complications (9.5%) versus 11 of the 128 SHS fixations (8.6%). This difference was not statistically significant (odds ratio 0.28, 95% Confidence intervals 0.50–2.80).

## Discussion

The results of this study show a clear difference in outcomes between those fractures treated with a fixed or static nail plate and those treated with a sliding hip screw. The nail fixation appears to produce fixation failure rates similar to that of the SHS. There was excellent agreement between the different studies. We only included studies from the year 2000 onwards. This was because the results for the early studies had shown variable results for the nail fixation with a tendency to a fixation failure rate that was twice that of the SHS [15,52]. Considerable changes have been made to the design of the intramedullary nails which make the results for these earlier studies obsolete.

The advantages of this study are the comprehensive literature search, standardised methods for systematic review [53] and meta-analysis and the concentrating on randomised studies to avoid biases. Problem with this study was that we had to exclude a number of studies on trochanteric fracture that did not separate out the results for the A3 fractures. A number of these studies used the Jensen and Michaleston classification of trochanteric fractures

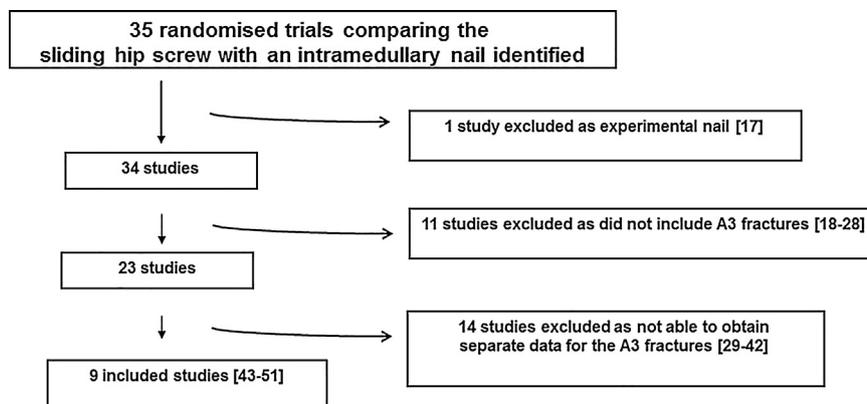


Fig. 1. Flow diagram for the inclusion/exclusion of studies.

**Table 1**  
Characteristics of the included studies.

nor	Year	Number patients	Mean age (range)	% male	Type nail	Type plate	Score
Intramedullary nail versus fixed or static plates							
Pelet [50]	2001	26	71 (21-94)	35%	Gamma	90° blade plate	3
Sadowski [51]	2002	39	78 (63-93)	31%	PFN	Dynamic condylar screw	2
Haq [44]	2014	40	55 (39-73)	70%	PFN	Locking plate	3
Intramedullary nail versus the sliding hip screws							
Adams [43]	2001	16	81 (32-102) *	25% *	Gamma	SHS	4
Pajarinen [47]	2005	11	80 (69-91) *	33% *	PFN	SHS	2
Ovesen [46]	2006	10	79 (67-91) *	28% *	Gamma	SHS	3
Parker [48]	2012	58	82 (61-99)	10%	Targon PF	SHS	4
Matre [45]	2013	139	84 *	33% *	Intertan	SHS	3
Parker [49]	2017	31	82 (59-95)	16%	Targon PFT	SHS	4

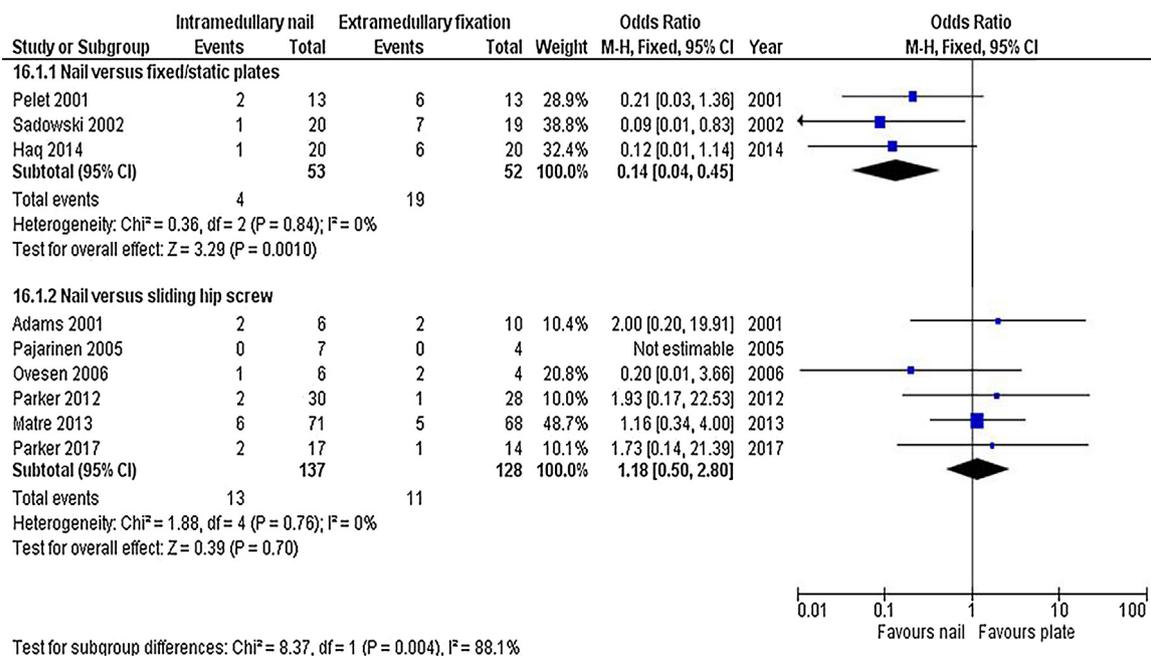
\*The figures were for the whole series of patients in the paper and not specific to just those with A3 fractures.

SHS = Sliding hip screw.

PFN = Proximal femoral nail.

Targon PF = Targon proximal femoral nail.

Targon PFT = Targon proximal femoral nail telescrew.



**Fig. 2.** Forest plot for the included studies.

which did not allow separation of the A3 fractures [54]. Other problems related to classification were the studies of Haq [44] and Pelet [50] which may have also included some A2 fractures. For these studies all fractures were described as having loss of lateral wall support allowing femoral medialisation and such fractures can be considered as equivalent to an A3 fracture. The methodology scoring of the included studies also indicated varying study methods with scores ranging from 2 to 4 out of a maximum of 6. This gives the potential for bias which may preclude making definite conclusions.

The role of the supplementary trochanteric stabilising plate for SHS fixation of trochanteric fractures remains uncertain. The plate is designed to reduce femoral medialisation by abutting against the greater trochanter. No such plates were used in either the studies of Parker [48,49] and there was no mention of stabilising plates being used in the other three SHS studies [43,46,47]. Whilst for the study of Matre 75% of patients treated with a SHS fixation had an addition of a stabilising plate [45]. To date there is little reported evidence from the literature to comment on the merit of these plates [55]. Within this review we

were not able to consider the complication of loss of fracture reduction with the fixation not cutting-out or failing. This is because the complication of loss of fixation was not clearly defined or reported within the included studies. It is possible that the addition of the stabilising plate will reduce any loss of fracture reduction, although this remains to be demonstrated in clinical studies, as does the role of this supplementary plate for the occurrence of fracture healing complications.

The proximal part of an intramedullary nail fixation may also play a part in reducing femoral medialisation by abutting against the femoral neck. A previous study has reported that increased femoral medialisation is associated with poorer regain of mobility [2]. Some of the randomised trials that have comparing an intramedullary nail with the SHS have suggested a tendency to slightly better regain of mobility for the nail [17,36,48,49,56].

A report from the Norwegian Hip Fracture Register of 2716 patients with reverse/transverse/subtrochanteric fractures treated with either an intramedullary nail or extramedullary fixation reported lower re-operation rates (6.4% versus 3.8%) and a tendency to better regain of function for those patients treated

with an intramedullary nail [57]. This study included subtrochanteric fractures making direct comparison with just A3 fractures difficult. 63% of the extramedullary fixations had a supplementary trochanteric stabilising plate.

In summary this study demonstrated that there are clear differences (four fold) in the occurrence of fracture healing complications for A3 fractures for static/fixed nail plates compared to either the SHS or an intramedullary nail. A similar complication rate was seen for either an intramedullary nail or the SHS. Therefore it is acceptable to conclude that A3 fractures should not be treated using a fixed/static plate but it is incorrect to state that intramedullary nail fixation is superior to a SHS. Further studies comparing contemporary intramedullary implants with a sliding hip screw are justified, with particular reference to assessing functional outcomes. The role of a trochanteric stabilising plate used in conjunction with a SHS fixation needs to be evaluated.

### Conflict of interest statement

None of the authors have any conflict of interest in relationship to this article.

### Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.injury.2018.05.017>.

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