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PREOPERATIVE POSTERIOR TILT INCREASES THE RISK FOR LATER CONVERSION TO ARTHROPLASTY AFTER OSTEOSYNTHESIS FOR FEMORAL NECK FRACTURE: A STUDY OF 301 CASES WITH A MEAN FOLLOW-UP OF 3 YEARS

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Reisiluun kaulan murtuma tarkoittaa murtumaa reisiluun pään ja intertrokanteerisen linjan välisellä alueella. Reisiluun kaulan murtumat jaetaan intrakapsulaarisiin ja ekstrakapsulaarisiin murtumiin näiden sijainnin mukaan lonkkanivelen nivelkapselin suhteen. Murtumat jaetaan dislokoituneisiin ja dislokoitumattomiin murtumiin. Käytännössä kaikki lonkkamurtumat hoidetaan nykyään operatiivisesti, joko osteosynteesillä tai asettamalla tekonivel. Reisiluun kaulan murtumien operatiivinen hoito johtaa parempaan luutumiseen ja harvemmin avaskulaariseen nekroosiin kuin konservatiivinen hoito. Nuorilla potilailla (alle 65-vuotiaat) yleisin hoitokäytäntö on murtuman reduktio ja stabiili fiksaatio. Reisiluun pää pyritään säästämään.

Osteosynteesillä hoidetuilla potilailla on suurempi riski joutua uusintaleikkaukseen kuin tekonivelleikatuilla. Kirjallisuuden mukaan riskitekijöitä joutua uusintaleikkaukseen osteosynteesin jälkeen ovat primaarivaiheen dislokoitunut murtuma, epäonnistunut reduktio ja reisiluun pään takakallistus (posterior tilt).

Tutkimukseni tarkoituksena oli selvittää kolmen ruuvin osteosynteesillä hoidettujen lonkkamurtumapotilaiden riskitekijöitä joutua uusintaleikkaukseen ja myöhempään tekonivelleikkaukseen. Tutkimusaineistoon sisällytettiin 1.1.2012-31.12.2017 välisenä aikana Turun Yliopistollisessa keskussairaalassa kolmella kanyloidulla ruuvilla hoidetut lonkkamurtumapotilaat. Potilastiedoista tilastoitiin sukupuoli, ikä leikkaushetkellä, murtuman puoli, vammaenergia, leikkausviive sekä uusintaleikkaukset. Seuranta-aikaa jatkettiin joko potilaan kuolemaan, proteesileikkaukseen tai 1.1.2020 saakka. Potilaiden pre-operatiivista röntgenkuvista määritettiin dislokaatioaste ja mitattiin takakallistus. Post-operatiivisista röntgenkuvista määritettiin dislokaatio, mitattiin reisiluun varren ja ruuvien välinen kulma sekä mitattiin takakallistus. Näistä muuttujista tehtiin tilastolliset analyysit. Uusintaleikkaukseen joutui 25% potilaista. Potilailla, joilla oli dislokoitunut murtuma tai pre-operatiivisessa röntgenkuvassa takakallistus ≥20° tai <0°, oli suurempi riski myöhempään tekonivelleikkaukseen.

Asiasanat: reisiluun kaulan murtuma, uusintaleikkaus, tekonivel

Preoperative posterior tilt increases the risk for later conversion to arthroplasty after osteosynthesis for femoral neck fracture: A study of 301 cases with a mean follow-up of 3 years

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Abstract

Background and purpose: Femoral neck fractures (FNF) are one of the most common injury among the elderly. The treatment of FNFs is either internal fixation or primary arthroplasty. The main aim of this study was to assess risk factors associated with fixation failure leading to further arthroplasty in FNFs treated with cannulated screws.

Patients and methods: Data on internal fixations of FNFs performed in Turku University hospital between January 1st 2012 and December 31st 2017 were collected retrospectively from the patient database. Radiographical measurements were performed for pre-operative dislocation and posterior tilt, post-operative dislocation, reduction quality and implant shaft angle.

Results: 301 cases were included in the study. The overall reoperation rate was 25% and conversion to arthroplasty was performed in 16% of cases. In the multiple variant analysis, adjusted for age and sex, non-dislocated fractures with 0-20° pre-operative posterior tilt had significantly lower risk for later conversion to arthroplasty compared to non-dislocated fractures with ≤0° or ≥20° posterior tilt (OR 4.0 95% Cl 1.8-8.6, p=0.0005) and dislocated fractures (OR 7.2 95% CI 3.0-17.4, p<0.0001). No statistically significant association was found between pre-operatively non-dislocated fractures with <0° or ≥20° posterior tilt and dislocated fractures (OR 0.6 95% Cl 0.2-1.3, p=0.2).

Interpretation: Dislocated fractures and fractures with pre-operative posterior tilt <0° or ≥20° have considerably increased risk for reoperation and conversion to arthroplasty. Primary arthroplasty should be considered as treatment for dislocated femoral neck fractures and fractures with >20° or <0° posterior tilt, especially for fragile patients to avoid further operations.

Introduction

A femoral neck fracture (FNF) is one of the most common injuries among elderly patients leading to increased morbidity and mortality (Braithwaite et al. 2003, Frost et al. 2013). Surgical treatment is the gold standard in treatment of FNF and is associated with lower mortality and higher union-rates compared to non-operative treatment (Xu et al. 2017). Operative treatment options for FNFs are internal fixation and arthroplasty. Internal fixation is a considerably simpler operation than arthroplasty, with less blood loss, shorter duration of surgery and fewer hospitalization days (Lu et al. 2017, Dolatowski et al. 2019). However, especially among elderly patients internal fixation has higher reoperation rates than arthroplasty, which lead to higher healthcare costs and increased morbidity (Wachtl et al. 2003, Palm et al. 2013, Brox et al. 2015). One of the most common reoperation after internal fixation is implant removal surgery, which is usually classified as minor surgery. Reoperations after arthroplasty are, in contrast, usually more severe and most commonly performed due to dislocation, periprosthetic fracture and infection (Bartels et al. 2018)(Nyholm et al. 2018)(Moerman et al. 2018).

FNFs are divided into non-dislocated and dislocated fractures according to Garden classification (Garden 1961, Kazley JM, Banerjee S, Abousayed MM 2018). In the literature dislocated fracture and inadequate fracture reduction have been shown to be risk factors for fixation failure and reoperations of FNFs treated with internal fixation (Tidermark et al. 2003, Gao et al. 2012, Yang et al. 2013, Araujo et al. 2014, Jiang et al. 2015). Definition of posterior tilt was first introduced by Palm et al. in 2009 and has been further validated (Palm et al. 2009, Kalsbeek et al. 2020). Posterior tilt of the femoral head over 20 degrees in the lateral view has been shown to be an individual predictor of failure in non-displaced FNFs (Palm et al. 2009, Okike et al. 2019, Nielsen et al. 2020), though this has not been seen in all studies (Lapidus et al. 2013). Lately, also the quality of reduction from lateral view has been studied and a correlation between postoperative posterior tilt of the femoral head and reoperations has been found (Nyholm et al. 2018, 2019).

The main aim of this study was to assess risk factors associated with fixation failure leading to further arthroplasty in FNFs treated with cannulated screws. Our hypothesis was that fracture dislocation,

including preoperative posterior tilt of the femoral head, increases risk for later conversion to arthroplasty.

Patients and methods

A retrospective review of all patients with an acute FNF operated with cannulated screws at the Turku University Hospital, Turku, Finland, between January 1st 2012 and December 31st 2017 was conducted. The electronic patient record system (Uranus Miranda, CGI Finland) was searched using a combination of the femoral neck fracture diagnosis code (ICD-10: S72.0) and surgical procedure code for cannulated screws (NOMESCO code, Finnish version, NFJ50).

The data retrieved from the medical charts included patients' sex, age, fracture side, mechanism of injury, American Society of Anesthesiologists Classification (ASA-classification, 1-5 and time to surgery. Mechanism of injury was divided into two groups: low-energy trauma (fall on the same level) and high-energy trauma (all other injury mechanisms). Time to surgery was calculated from the hospital admission date to the surgery date. Patients were divided into three groups; those operated within the first 24 hours after hospital admission, those operated between 24 and 48 hours and those operated over 48 hours after hospital admission.

Patients' pre- and postoperative radiographs were analyzed retrospectively using the Carestream Picture archiving and communication systems (PACS) software. Radiographic measurements included preoperative fracture dislocation, preoperative posterior tilt, and the quality of reduction. Preoperative fracture dislocation was classified either into non-dislocated or dislocated fracture by the Garden classification in the anteroposterior radiograph (Garden 1961). Posterior tilt was measured with the technique introduced by Palm et al from the shoot through lateral radiograph (Palm et al. 2009). Non-dislocated fractures (Garden 1 and 2) were then divided by posterior tilt into two groups (<20° and ≥20°). If an anterior tilt was detected, the case was included in to the ≥20° group based on earlier literature (Sjöholm et al. 2019). Quality of reduction was determined by measuring postoperative posterior tilt and cases were divided into three groups: non-dislocated in AP-view and 0-10° posterior tilt, non-dislocated

in AP-view and ≥10° or ≤0° posterior tilt, and dislocated in AP-view. Postoperative dislocation in AP-view was determined by drawing Shenton's line into AP-view radiograph. If the Shenton's line was not intact, the case was considered as dislocated. A fracture was considered well reduced if there was <10° posterior tilt and no dislocation in AP-view otherwise a fracture was considered as inadequately reduced. As in the pre-operative measurements, if anterior tilt was detected, fracture was included in the ≥10° group. Implant shaft angles were measured from the most inferior screw and divided into two groups; ≤125° and >125° based on previous literature (Nyholm et al. 2018). All measurements were performed by one author (J.H) and supervised by musculoskeletal radiologist with 8 years of experience (V.H).

Data of reoperations during the follow-up time was collected from the patient records. All reoperations were registered and included in the data. The main outcome of interest was conversion to arthroplasty.

Statistical methods

Descriptive statistics are shown as the number of subjects and proportions for categorical variables. For normally distributed variables, means with standard deviations (*SD*) and range (min-max) are presented, and median with interquartile range (IQR) and range (min-max) otherwise.

Predictors for conversion to arthroplasty were modelled with logistic regression with the following independent variables: age, gender, ASA-class, time to surgery, fracture side, mechanism of injury, dislocation. Multiple logistic regression model for same dependent variable included age, gender and dislocation as independent variables. Predictors for any reoperation were modelled with logistic regression were age, gender, ASA-class, time to surgery, fracture side, mechanism of surgery, reoperations and implant shaft angle were independent variables. Odds ratios (OR) and their 95% confidence intervals were calculated from this logistic regression model. Non-parametric Kaplan-Meier method was used with cumulative incidence curve.

All statistical tests were performed as 2-sided, with a significance level set at 0.05. The analyses were performed using SAS® System, version 9.4 for Windows (SAS Institute Inc., Cary, NC, USA).

Ethics, registration, data sharing plan, funding, and potential conflicts of interest

Ethical approval was obtained from the Local Ethical Review board in Turku University Hospital (T01/018/19), date of issue December 4, 2019. This research did not receive any funding. All authors declare no conflict of interest.

Results

The data contain information on 352 operations using cannulated screws performed on 341 patients during the study period. Six patients had both femoral necks fixated due to FNF and were included twice in the data as two separate cases. 51 patients were excluded for various reasons (Figure 1) leaving 301 cases eligible for the data analysis. Patient records were evaluated from the injury until to either the time of death, conversion to arthroplasty or until January 1st 2020, whichever occurred first. All patients had at least one follow-up visit with postoperative hip radiographs taken (supine AP), approximately 6 weeks after the primary surgery. Further follow-up visits were arranged if needed.

The mean age was 73 years (range 20 - 102) and 168 (56%) patients were women. 113 (38%) patients died during the follow-up period and with 42 (14%) dying during the first year after the surgery (Table 1). The mean follow-up period was 3.3 years (range 0-8 years). In 75 (25%) cases the patient had any reoperation during the follow up time and a total of 49 (16%) patients underwent a conversion to arthroplasty (Table 2). Four patients underwent conversion to arthroplasty after implant removal surgery and were included in the conversion to arthroplasty group.

Risk of conversion to arthroplasty

Fracture dislocation and inadequate reduction were associated with statistically significant increase in the risk of conversion to arthroplasty. In the univariate analysis patients with non-dislocated fractures and 0-20° pre-operative posterior tilt were less likely to lead to arthroplasty compared with dislocated fractures (OR 0.2, 95% CI 0.1-0.4, p<0.0001) and with fractures with pre-operative posterior tilt <0° or ≥20° (OR 0.3,

95% Cl 0.1-0.6). Also, adequately reduced fractures had a lower risk of conversion to arthroplasty compared to post-operatively dislocated fractures (OR 0.1, 95% CI 0.01-0.8, p=0.03). Patients with pre-operative posterior tilt ≥20° or <0° but with adequate reduction had significantly higher risk to arthroplasty compared to patients with adequate pre- and post-operative posterior tilt (OR 3.4 95% CI 1.3-8.8, p=0.01). Further, patients with 0-20° pre-operative posterior tilt but with inadequate reduction had statistically significant increased risk to arthroplasty compared to patients with adequate pre- and post-operative posterior tilt (OR 3.4 CI 95% 1.2-9.7, p=0.02).

In the multiple variant analysis, adjusted for age and sex, non-dislocated fractures with 0-20° pre-operative posterior tilt had significantly lower risk for later conversion to arthroplasty compared to non-dislocated fractures with ≤0° or ≥20° posterior tilt (OR 4.0 95% Cl 1.8-8.6, p=0.0005) and dislocated fractures (OR 7.2 95% CI 3.0-17.4, p<0.0001). No statistically significant association was found between pre-operatively non-dislocated fractures with <0° or ≥20° posterior tilt and dislocated fractures (OR 0.6 95% Cl 0.2-1.3, p=0.2) (Table 3).

Age, ASA-class, time to surgery, sex, fracture side, implant shaft angle or mechanism of injury did not have statistically significant association for conversion to arthroplasty (Table 3).

Risk of any reoperation

Patients with non-dislocated fracture and posterior tilt 0-20° had a lower risk of requiring reoperation compared with patients with dislocated fractures (OR 0.2 95% CI 0.08-0.3, p<0.0001).

Patients under 65 years and patients between 65-75 years had a higher risk for reoperation compared to patients over 75 [(OR 2.5 95% CI 1.3-4.8, p=0.004) (OR 2.4 95% CI 1.3-4.6, p=0.01), respectively]. Implant shaft angle was a decreasing risk factor for reoperation as a continuous variable (OR 0.96 CI 95% CI 0.9-0.99, p=0.01) but did not have a significant association in groups (≤125° and >125°). No statistically significant association was found between reduction, time to surgery, ASA-class, sex, fracture side, or mechanism of injury and reoperations (Table 4).

Discussion

We found that pre-operative FNF dislocation, including posterior tilt <0° or ≥20°, increased the risk both for later conversion to arthroplasty and any reoperation after internal fixation of FNF. Also, inadequate reduction was associated with higher conversion to arthroplasty and reoperation rates. No significant association was found between conversion to arthroplasty and age, sex, implant shaft angle, time to surgery, fracture side, or mechanism of injury.

The total reoperation rate in our study population was 25% and 16% of the patients underwent a conversion to arthroplasty. These findings are similar to previous studies which have reported reoperation rates range between 16% and 33% (Palm et al. 2009, Lapidus et al. 2013, Bartels et al. 2018, Nyholm et al. 2018, 2019, Okike et al. 2019, Stockton et al. 2019). Reoperation rates have been found to vary in literature based on which operations have been defined as relevant reoperations (Nyholm et al. 2018, Stockton et al. 2019). In our study, every reoperation was included and conversion to arthroplasty was studied as a separate end point. Majority of the reoperations were conversions to arthroplasty and implant removal surgeries as in the previous studies (Stockton et al. 2019)(Nyholm et al. 2018). Only 4 reoperations were performed due to other reasons.

While assessing the later risk for conversion to arthroplasty, preoperative dislocation, including suboptimal posterior tilt, and inadequate postoperative reduction were associated with increased risk for arthroplasty. Eight percent of the patients with non-displaced FNF and posterior tilt between 0° and 20° underwent later conversion to arthroplasty compared with 26% of patients with non-displaced FNF and posterior tilt of <0° or ≥20°. Further, there was no difference in the risk for conversion to arthroplasty between patients with non-displaced FNF with <0° or ≥20° posterior tilt and patients with displaced FNF, suggesting that the effect of posterior tilt to the later failure of internal fixation is as important as dislocation in the anteroposterior radiograph. Comparably to our results, Okike et al. reported increased risk for later conversion to arthroplasty for patients with posterior tilt ≥20° (Okike et al. 2019). Stockton et al. reported 14% conversion to arthroplasty rate for 18 to 50 years old patients (Stockton et al. 2019). However, the majority of FNF patients are old and fragile and delay in rehabilitation caused by suboptimal

choice for the primary operation, might lead to inferior outcome. Therefore, based on our results and earlier literature, fragile patients with preoperative posterior tilt ≥20° are likely to benefit from arthroplasty as the primary operation to avoid reoperations.

Preoperative posterior tilt of <0° or ≥20° in non-displaced FNFs was also associated with an increased risk for reoperation for any reason. Comparably with the risk for conversion to arthroplasty, there was no statistically significant difference between the risk for reoperation between this group and patients with displaced FNF. Insufficient postoperative reduction was associated with higher rate of conversion to arthroplasty. Adequate reduction was seen in 52% of the dislocated fractures and fractures with pre-operative posterior tilt of <0° and >20°. However, only 40 patients with non-displaced fracture and adequate posterior tilt had insufficient reduction, preoperative dislocation level might covariate with the reduction results. The groups for posterior tilt were chosen to correspond with the prior literature. The posterior tilt groups had different limits pre- and post-operatively, which might explain the insufficient reduction of pre-operatively non-dislocated fractures. Some were considered inadequately reduced even though the posture remained intact. Despite of this, one should aim to good reduction during the surgery.

Further, while assessing all reoperations, we found an association between age and reoperation rate; younger patients had increased risk for reoperation but not for conversion to arthroplasty. Similar results of younger patients having an increased risk for reoperation have been published earlier (Slobogean et al. 2015, Nyholm et al. 2018). Though, these studies did not report the risk for later conversion to arthroplasty separately. Palm et al. and Dolatowski et al, on the other hand, did not find an association between age and reoperation (Palm et al. 2009, Dolatowski et al. 2016). Implant removal surgery is typically performed to younger patients with high activity demands (Slobogean et al. 2015). Additionally, trauma mechanism is more often high-energy trauma in the younger population. This may explain the association between age and reoperations. We did not find a statistically significant association between time to surgery and reoperation, in contrast with prior literature (Nyholm et al. 2018,

2019). In many previous studies surgical delay has been defined with the accuracy of 12 hours. In this study accuracy on surgical delay was 24 hours, potentially impacting the statistical analysis.

Femoral neck fracture has been reported to lead to increased mortality and morbidity (Braithwaite et al. 2003, Frost et al. 2013). In this study, a total of 38% of the patients died during the follow-up and 14% of patients died during the first year after the surgery. Most fractures studied were low-energy fractures which might indicate that patients were frail, as well explain the observed high mortality rate. Pre-operative mobility, cognitive impairment and surgical delay have been found to associate with the risk of death after FNF surgery (Moja et al. 2012, Smith et al. 2014). Also increasing age and high ASA-score have been found to be possible pre-operative predictors of death (Smith et al. 2014, Nyholm et al. 2019). We did not investigate the impact of these factors or further risk factors for death on FNF patients, but these factors did not affect to reoperation rate.

We acknowledge that our study has some limitations. First, the data was collected retrospectively, thus patient selection for internal fixation was affected by patient and surgeon related factors after hospital admission. Second, we did not have patient reported outcome measures (PROMs), as Turku university hospital does not collect PROMs routinely on trauma patients. Patients treated with arthroplasty have been reported to be more satisfied and reported less pain compared to internal fixation (Bartels et al. 2018). Additionally, our outcome of interests was reoperation, and it is possible that some patients might be dissatisfied to their hip despite of not having a reoperation or conversion to arthroplasty.

We conclude that with considerably high percent of reoperation and later arthroplasty after osteosynthesis of FNF, fractures with posterior tilt >20° or <0° should be treated as dislocated fracture. Primary arthroplasty should be considered as treatment for dislocated femoral neck fractures and fractures with >20° or <0° posterior tilt, especially for fragile patients to avoid further operations.

Author contributions

JH: Data collection, radiographical measurements, interpretation of the results, main responsibility for writing of the manuscript. EE: Study design, interpretation of the results, writing the manuscript. VH: Radiographical measurements, interpretation of the results, writing the manuscript. KM: Study design, interpretation of the results, writing the manuscript. MKo: Statistical analysis, interpretation of the results, writing the manuscript. MKa: Study design, interpretation of the results, writing the manuscript. IL: Study design, interpretation of the results, writing the manuscript.

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Figure 1:

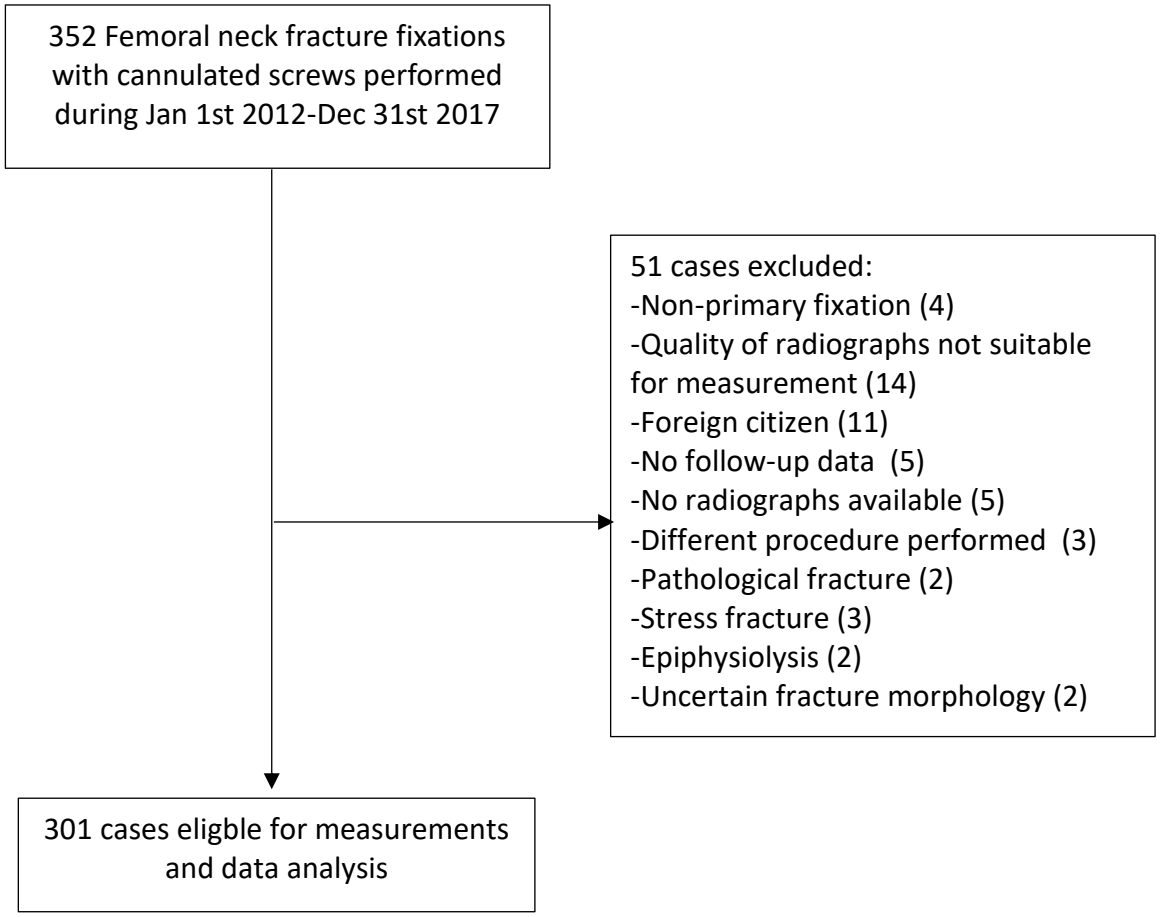
352 Femoral neck fracture fixations with cannulated screws performed during Jan 1st 2012-Dec 31st 2017
51 cases excluded:
-Non-primary fixation (4)
-Quality of radiographs not suitable for measurement (14)
-Foreign citizen (11)
-No follow-up data (5)
-No radiographs available (5)
-Different procedure performed (3)
-Pathological fracture (2)
-Stress fracture (3)
-Epiphysiolysis (2)
-Uncertain fracture morphology (2)
301 cases eligble for measurements and data analysis

Table 1:

Characteristics of the study population			
	Total	**Reoperation (%)***	**Conversion to arthroplasty (%)***
Total	**301**	**75 (24.9)**	**49 (16.3)**
Age			
<65	**77**	26 (33.8)	15 (19.5)
65-75	**74**	24 (32.4)	15 (20.3)
>75	**150**	25 (16.7)	19 (12.7)
Sex			
Male	**133**	38 (28.6)	23 (17.3)
Female	**168**	37 (22.0)	26 (15.5)
Fracture laterality			
Right	**124**	29 (23.4)	20 (16.1)
Left	**177**	46 (26.0)	29 (16.4)
Mechanism of injury			
Low-energy	**276**	65 (23.6)	42 (15.2)
High-energy	**25**	10 (40.0)	7 (28.0)
American Society of Anesthesiologist (ASA) score			
1-2	**77**	23 (29.9)	15 (19.5)
3	**169**	43 (25.4)	26 (15.4)
4-5	**52**	9 (17.3)	8 (15.4)
Data missing	**3**		
Time to surgery			
<24 hrs	**84**	25 (29.8)	17 (20.2)
24-48 hrs	**202**	48 (23.8)	31 (15.3)
>48 hrs	**15**	2 (13.3)	1 (6.7)
Dislocation			
Non-displaced, posterior tilt 0-20°	**192**	28 (14.6)	16 (8.3)
Non-displaced, posterior tilt ≥20° or <0°	**62**	22 (35.5)	16 (25.8)
Displaced	**47**	25 (53.2)	17 (36.2)
Implant shaft angle			
≤125°	**52**	16 (30.8)	9 (17.3)
>125°	**249**	59 (23.7)	40 (16.1)

Reduction			
Non-displaced in AP-view, posterior tilt 0-10°	**209**	39 (18.7)	19 (9.1)
Non-displaced in AP-view, posterior tilt ≥10° or <0°	**88**	34 (38.6)	28 (31.8)
Displaced	**4**	2 (50.0)	2 (50.0)
***The percentage of the total for the given row in parentheses**			

Table 2:

Reoperations	
Conversion to arthroplasty	49
Removal of implants	22
Revision due to infection	2
Re-osteosynthesis with another fixation device	2
Total	**75**

Table 3:

Analysis of Risk of Conversion to arthroplasty						
	Univariate analysis			**Multivariate analysis**		
	OR	**95% CI**	**P value**	**OR**	**95% CI**	**P value**
Age						
<65	1.7	0.8-3.5	0.2	0.9	0.4-2.1	0.7
65-75	1.8	0.8-3.7	0.1	1.4	0.6-3.1	0.4
>75	1			1		
Sex						
Male	1.1	0.6-2.1	0.7	0.8	0.4-1.6	0.5
Female	1			1		
Fracture laterality						
Right	0.98	0.5-1-8	0.95			
Left	1					
Mechanism of injury						
Low-energy	0.5	0.2-1.2	0.1			
High-energy	1					
ASA score						
1-2	1.3	0.5-3-4	0.6			
3	1.0	0.4-2.4	1.0			
4-5	1					
Time to surgery						
<24 hrs	1.4	0.7-2.7	0.3			
24-48 hrs	1					
>48 hrs	0.4	0.05-3.1	0.4			
Dislocation						

Non-displaced, posterior tilt 0-20°	0.2	0.07-0.4	<0.0001*	1		
Non-displaced, posterior tilt ≥20° or <0°	0.6	0.3-1.4	0.2	3.0	1.8-8.6	0.0005*
Displaced	1			7.2	3.0-17.4	<0.0001*
Implant shaft angle						
≤125°	1.1	0.5-2.4	0.8			
>125°	1					
Reduction						
Non-displaced in AP-view, posterior tilt 0-10°	0.1	0.01-0.8	0.03*			
Non-displaced in AP-view, posterior tilt ≥10° or <0°	0.5	0.06-3.5	0.5			
Displaced	1					
***Statistically significant**						

Table 4:

Analysis of Risk of Reoperation			
	OR	**95% CI**	**P value**
Age			
<65	2.5	1.3-4.8	0.004*
65-75	2.4	1.3-4.6	0.008*
>75	1		
Sex			
Male	1.4	0.8-2.4	0.2
Female	1		
Fracture laterality			
Right	0.9	0.5-1.5	0.6
Left	1		
Mechanism of injury			
Low-energy	0.5	0.2-1.1	0.07
High-energy	1		
ASA score			
1-2	2.0	0.9-4.9	0.1
3	1.6	0.7-3.6	0.2
4-5	1		

Time to surgery			
<24 hrs	1.4	0.8-2.3	0.3
24-48 hrs	1		
>48 hrs	0.5	0.1-2.3	0.4
Dislocation			
Non-displaced, posterior tilt 0-20°	0.2	0.08-0.3	<0.0001*
Non-displaced, posterior tilt ≥20° or <0°	0.5	0.2-1.0	0.07
Displaced	1		
Implant shaft angle			
≤125°	1.4	0.7-2.8	0.3
>125°	1		
Reduction			
Non-displaced in AP-view, posterior tilt 0-10°	0.2	0.03-1.7	0.1
Non-displaced in AP-view, posterior tilt ≥10° or <0°	0.6	0.09-4.7	0.7
Displaced	1		