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ORIGINAL STUDY

Evaluation of cerclage wiring in the treatment of subtrochanteric fractures

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Treatment of subtrochanteric fractures is challenging because of their typical displacement pattern. Use of circumferential cerclage wires can be added to intramedullary nailing to facilitate better anatomical reduction. Concerns exist regarding additional soft tissue damage and ischemia of the periosteum. The aim of this study was to assess the effect of cerclage on union and infection rates. The postoperative results of 115 patients over 11 years were retrospectively viewed. Twenty-three patients were treated with cerclage. The primary outcome measure was 'return to theatre for fixation failure'. There was no difference in reoperation rate or in infection rate. Average displacement of the lateral wall was larger (9mm vs 1,3mm) in the no-cerclage group (p=0,003). The mean duration of surgery in the cerclage group was 28 minutes longer (p=0.003). Cerclage wiring does not lead to higher re-operation, nor higher infection rates. The use of cerclage wire in open reduction is advocated when closed reduction is not satisfactory.

Keywords : Subtrochanteric fracture ; cerclage ; hip fracture ; intramedullary nailing ; femur fracture.

INTRODUCTION

Subtrochanteric fractures are fractures of the femoral bone in the subtrochanteric region, which starts at the upper part of the lesser trochanter and extends 5cm distally. Due to anatomical, biological and biomechanical factors subtrochanteric fractures are difficult to treat. They present with a typical mode of displacement due to their muscular attachments to the proximal fracture fragment. The deformity of the proximal fragment consists of flexion, abduction and external rotation as a result of the action of iliopsoas, gluteus medius and external rotators respectively *(7)*.

It is generally accepted that subtrochanteric fractures should be treated with an intramedullary nail. However, due to the typical mode of deformity it is often not possible to obtain a closed anatomical reduction, making the operative procedure technically difficult. If reduction is not satisfactory, an open reduction, with or without additional cerclage wiring, can be performed. Some authors promote the use of open reduction with cerclage wiring *(3,8,18)*. On the other hand, there is a historical idea within the orthopaedic community that cerclage wiring will lead to more soft tissue damage and periosteal ischemia, which will lead to poorer healing (delayed- and non-union) and higher rates of infection *(4,13)*.

The aim of this study was to assess the effect of cerclage wiring on union and infection rates.

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MATERIALS AND METHODS

This retrospective cohort study was performed in the orthopaedic department of Ghent University Hospital, Belgium.

Between January 1st 2006 and December 31th 2016 144 patients were treated for a subtrochanteric fracture. Inclusion criteria were : age >17 years with an intramedullary nailing for a subtrochanteric fracture. Exclusion criteria were : pathologic fracture, revision procedures, open fractures and segmental fractures. Most of the surgeries were performed by residents in training under supervision of the staff member on call. When anatomical reduction was not obtained, the decision to accept the reduction or to use additional (open) reduction techniques was at the discretion and personal preference of the treating surgeon.

All radiographs were reviewed to determine whether inclusion criteria were met, followed by a file review to check for exclusion criteria. Baseline demographic data and outcome measures were collected using following data : operation report, daily clinical follow-up notes, discharge letter, all lab-results including microbiology, pre- and postoperative radiographs.

The patients were divided in two cohorts : the cerclage and the no-cerclage group. Patients characteristics include gender, age at surgery, use of a long intramedullary nail, energy trauma and lost to follow-up (see Table I). Trauma mechanism was coded as high (victim in a motorized vehicle crash, fall from height >3m or pedestrian/cyclist hit by car >50km/h) vs. low energy trauma. Patients were seen on regular intervals and radiographs were performed to check for position of the prosthetic materials and to assess union of the fracture. If patients were followed for less than 12 months and there was no union on the last available radiograph, they were labelled 'lost to follow-up'.

The primary outcome measure was defined as : 'return to theatre for fixation failure at any time point for non-union or implant failure', as was used in the study of Hoskins et al. *(8)*. Secondary outcome measures were deep infection (defined as return to theatre for infection), non-union at 12 months, displacement of the lateral wall in mm, duration of surgery and change in femoral neck angle (defined as the difference between the shaft-neck angle between the operated and healthy side). Radiographical union was defined as bridging callus on at least three or four cortices on anterior-posterior (AP) and lateral radiographs. Lateral femoral wall displacement was measured on the first post-operative AP radiograph. The difference in shaft-neck angle was measured on a weight bearing pelvic radiograph, at any point in time.

All analyses were performed with the SPSS statistical package (IBM SPSS Statistics Subscription, build 1.0.0.580 64 bit edition). Data were described using the means and standard deviations for continuous and frequencies for categorical data. Chi-square tests were used to compare differences among categorical variables and student T-test for continues variables. P-values <0.05 were considered to be statistically significant.

RESULTS

144 cases of subtrochanteric fractures were identified over the 11-year period. 132 cases met the inclusion criteria and 15 cases were excluded because of pathologic, open or segmental fracture or re-operation. Two patients died before the first postoperative radiograph could be taken and were also excluded. In total 115 cases were available for further analysis.

Table I. — Patient Characteristics

	No-cerclage (n=92)	**Cerclage** (n=23)	P-value
Male gender	49% (45)	52% (12)	0.78
Age at surgery in years (mean ±SD)	67,17 (±21,953)	62,91 (±23,497)	0.70
Long nail	74% (68)	74% (17)	1.0
High energy trauma	77% (71)	87% (20)	0.30
Lost to follow-up	49% (45)	48% (11)	0.88

Table II. — Outcome measures

	No-cerclage	**Cerclage**	P-value
Return to theatre for implant failure (%) (n)	4,3% (4/92)	4,3% (1/23)	1.0
Return to theatre for infection (%) (n)	2,2% (2/92)	0% (0/23)	0,67
Non-union at 12 months (%) (n)	30,4% (14/46)	25% (3/12)	0,92
Time to union in months (mean ±SD)	8,62 (± 4,23)	6,91 (± 2,84)	0,22
Length of surgery minutes (mean ±SD)	92 (± 40)	120 (± 39)	0,003
Displacement of the lateral femoral wall in mm (mean ±SD)	9,04 (± 11,9)	1,30 (± 2,62)	0,003
Postoperative femoral neck angle in ° (mean ±SD)	126,5 (± 5,4)	128,6 (± 6,7)	0,11

Table I presents the demographic, trauma and operative factors of the patients. 23 of the 115 cases (20%) received additional circumferential cerclage wires. The cohort was divided in two groups : cerclage vs. no-cerclage. There were no significant differences found between the two groups, therefore are the cerclage and the no-cerclage groups comparable. There was a lost to follow-up of 48-49% due to radiographic follow-up less than 12 months. In 26% of the cases a short femoral nail was used for osteosynthesis instead of a long nail.

Comparison of the 'cerclage' and 'no-cerclage' groups can be found in Table II. For our primary outcome measure, the re-operation rate, was no significant difference between the groups with a percentage of 4,3% in the cerclage as well as the no-cerclage group. In the no-cerclage group two patients received revision surgery for deep infection, none in the cerclage group. Due to this low number the difference did not reach significance. Non-union at 12 months was present in 14/46 (30%) in the group without cerclage and in 3/12 (25%) in the group with cerclage. Also the time to union did not show a significant difference with 8,62 in the no-cerclage vs. 6,91 months until union in the cerclage group respectively.

The duration of surgery was significantly longer in the group who had cerclage wiring, with a mean of 120 minutes operating time vs. 92 minutes in the group without cerclage wire (p=0.003). The postoperative displacement of the lateral wall was significantly larger in the no-cerclage group with a mean displacement of 9,04mm versus 1,30mm in the cerclage group (p=0.003). In the cerclage group there was a trend towards less varus deformity with a postoperative neck-shaft angle of 128,6° versus 126,5° in the group that did not have cerclage (p=0.11).

DISCUSSION

In this study we were not able to show a significant difference in return to theatre for implant failure or non-union between two groups of patients with subtrochanteric fractures, that were treated with an intramedullary nail with or without cerclage wiring. When analysing the data of Table I. it is surprising to see that 26% of patients was treated with a short nail, where there is an overall consensus that for unstable fractures a long cephalo-medullary nail should be used to avoid implant failure *(6,11,15,17)*.

Although the difference was not significant, there was a trend towards more high-energy trauma in the cerclage group. This was expected as we hypothesized that higher energy trauma leads to more displacement of the fracture elements, and thus requiring cerclage wiring for reduction. There is a large proportion lost to follow-up, with very similar percentages between both groups. There are several explanations for the lost to follow-up. One of the most important factors is that the mortality rate of hip fractures in elderly people can be as high as 26,8% in the first postoperative year. Also an important proportion of the patients resided or were admitted after their fracture in a retirement / nursing home, where outpatient clinic follow-up can be challenging *(10)*.

For the primary outcome measure there was a relatively low number of patients requiring revision surgery with 4,3% in both groups. Other authors report revision rates up to 10% *(5,17)*. This could be explained by the large group of lost to

follow-up. Otherwise could it be a reflection of the conservative approach at our institution, where patients with an asymptomatic non-union were not advised to undergo revision surgery. Non-union at 12 months was present in 25% and 30,4% of the cases in respectively the cerclage and no-cerclage group.

The duration of surgery was significantly longer in the cerclage group, a logical observation that is no different from other authors *(14)*. The only major concern is that theoretically a longer operating time could yield a higher chance of wound infection. In our study infection rates were not significantly different between groups. There were two deep infections in the no-cerclage group that required a re-intervention. In the cerclage group there was one superficial infection treated with oral antibiotics.

Reduction was better when cerclage wiring was used. In the cerclage group the displacement of the lateral wall was only 1,3mm as compared to 9,04mm in the no-cerclage group (p=0.003). The post-operative neck-shaft angle showed a trend towards less varus deformity in the cerclage group. This can be important because varus deformity is considered one of the reasons for nonunion. Due to shearing forces produced by the varus deformity, the fracture site is hindered from union. The study of Riehl et al. *(16)* showed that the presence of a malreduction greater than 10° in any plane results in a significantly higher rate of delayed or nonunion. Both lateral wall displacement and varus deformity are important since the quality of reduction is associated with shorter time to union, less non-union and superior functional outcome as shown in recent studies *(5,8,17)*.

The current general idea that placing cables or wires around the bone will cause ischemia arises from the communications of sir John Charnley *(4)* who speaks of 'the evil effects of the circumferential suture' in 1950. However, the blood supply to the bone is thought to be circumferential, rather than longitudinal. Placing a cerclage wire has only minimal interference with this circumferential blood supply. As Perren et al. *(14)* showed in a sheep model, the ischaemic zone underneath a cerclage cable is only 0.36mm wide. Furthermore, Apivatthakakul et al. *(2)* showed with a cadaveric study on 18 femurs that percutaneous cerclage wiring resulted in only minimal disruption of the femoral blood supply, and that rupture of one or more perforators was compensated by their anastomoses.

Other authors have shown promising results from the use of cerclage wire as an adjunct to intramedullary nailing. Hoskins et al. *(8)* reviewed retrospectively 134 cases, where 51,1% were treated with closed reduction, 34,1% with open reduction without cerclage and 14,8% with open reduction with cerclage. No cases with cerclage wire had return to theatre, in contrast to 15% in the open without cerclage and 8,8% in the closed reduction group. Kennedy et al. *(9)* performed a retrospective review of 17 patients who were treated with an intramedullary nail and cerclage for a subtrochanteric fracture. Only one patient required a second operation to treat a non-union, all others healed. All patients returned to their previous place of residence after hospital discharge. In the retrospective study of Ban et al. *(3)* 60 patients were treated with cerclage and there were 4 reoperations. One due to deep infection, one due to technical failure during osteosynthesis, one had a screw cut out, and one sustained a new fracture following a new fall. They stated that the application of circumferential wires is an option as it provides good primary reduction with no apparent increase in reoperation rate. Shukla et al. *(17)* identified that malreduction (varus alignment) is the most important factor for non-union. They retrospectively reviewed 102 cases, where 19 fractures were fixed in varus (angulation > 10°). Implant failure, 9 of the 10 malunions and all 3 of the non-unions occurred in the varus group whilst only 1 malunion occurred in the satisfactory reduction group (p<0,0001). Furthermore the hospital stay for patients with a malreduction was 26 days vs. 16 days for patients with a neutral postoperative alignment. Afsari et al. *(1)* routinely used clamp-assisted reduction in 44 patients with a subtrochanteric fracture, in 9 an additional cerclage wire was used. All but one patient with cerclage wires had union of their fracture within 6 months postoperatively, there were no infections. The numerous clinical studies are also supported by a biomechanical study by Müller et al. *(12)* who showed that cerclage wire application

may substantially reduce the risk of osteosynthesis failure in complex fractures.

We are aware of important limitations to our study. A major issue with retrospective data collection is the variability in quality of the available data. We started data collection in patients from 2006 where the digital availability of data was lower than for the more recent years. However, operation reports, microbiology data and radiographs were available for all patients making the data reliable for our analyses.

Although the high rates of lost to follow-up are equal in both groups, and despite the fact that there are plausible explanations for the loss to follow-up in this group of patients, it still raises a concern for possible bias.

CONCLUSION

In our study we compared patients that were treated for a subtrochanteric fracture with or without additional cerclage wires and found neither difference in re-operation rate, nor an increase in infection rate when cerclage was used. Although these results should be interpreted with caution, they are in line with conclusions of numerous recent studies showing that the use of cerclage wires is not detrimental for fracture healing. We find that the potential benefit of an anatomical reduction outweighs the minor complications associated with an open reduction and advocate the use of open reduction with cerclage wire when closed reduction is not satisfactory.

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