Evaluation of cerclage wiring in the treatment of subtrochanteric fractures

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Promotor 1: Prof. dr. E. Audenaert
Promotor 2: Prof. Dr. J. Victor

Masterproef voorgedragen in de master in de specialistische geneeskunde
Orthopedie en traumatologie
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Foreword

The past 2 years I have studied the effects of the use of cerclage wire in the treatment of subtrochanteric fractures. I would like to thank my two promotors, Prof. Dr. E. Audenaert and Prof. Dr. J. Victor for this opportunity and their wise advise during this process.

Special thanks go to medical student Sigrid fauconnier who has put a lot of effort in gathering data.

At last I would like to thank my wife and kids for their patience and support.

Marno van Lieshout June 2017
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1. **Abstract**

Subtrochanteric fractures are a subgroup of femoral fractures with a distinct pattern of displacement. To counteract this displacement and obtain a better or anatomical reduction the osteosynthesis with an intramedullary nail can be augmented with one or more cerclage wires. The use of cerclage wires is controversial as some surgeons feel it is harmful because of additional soft tissue damage and ischemia of the periosteum. On the other hand there is a group of surgeons who believe that anatomical reduction is the key to successful healing of subtrochanteric fractures.

In this retrospective study we compared the postoperative results of 115 patients who had their subtrochanteric fracture fixed with, or without cerclage augmentation. 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 between the two groups. In the group of patients treated without cerclage there were two deep infections versus none in the cerclage group, this difference was not statistically significant. Duration of surgery in the cerclage group was an average 28 minutes longer (p=0.003). Displacement of the lateral wall was on average 1.3mm in the cerclage group and 9mm in the group without cerclage.

Important limitations of this study are its retrospective nature and the 50% loss to follow-up. The results are however in line with the conclusions of numerous recent articles. Therefore we advocate the use of open reduction and cerclage wire when satisfactory reduction is not achieved with closed reduction.
2. INTRODUCTION

Subtrochanteric fractures are fractures of the femoral bone with the primary fracture line in the subtrochanteric region. The subtrochanteric region starts at the height of the minor trochanter and extends 5cm distally. They present with a typical mode of displacement, which is the result of muscular attachments to the proximal fracture fragment. The deformity of the proximal fragment consists of flexion, abduction and external rotation as result of the action of the iliopsoas, gluteus medius and external rotator muscles respectively (1). 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 an anatomical reduction, as is shown in figure 1. If reduction is not satisfactory, an open reduction, with or without additional cerclage wiring, can be performed (figure 2.). Some authors promote the use of open reduction with cerclage wiring (2–4). 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.

3. MATERIALS & METHODS

• Cohort description

We performed a retrospective analysis of all patients treated in our hospital with an intramedullary nail for subtrochanteric femoral fractures in the period between January 1st 2006 and December 31st 2016. Patients were selected on the basis of the surgery coding in the operating theatre. Inclusion criteria: All patients >17 years of age, with an intramedullary nailing for a subtrochanteric fracture. Exclusion criteria were: pathologic fractures, revision procedures, open fractures and segmental fractures.

All radiographs were reviewed to determine whether inclusion criteria were met, followed by a file review to check for exclusion criteria.
• Surgical technique

All patients were operated at the university hospital Ghent. Most surgeries were performed by residents in training under supervision of the staff member on call. Patients received general anaesthesia. Installation was on a fracture table where a closed reduction manoeuvre was performed. Reduction was checked with fluoroscopy. 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. After reduction a 5cm lateral incision just proximal to the greater trochanter was made. Sharp surgical dissection to the greater trochanter was performed and with an awl the medullary canal was opened from the tip of the greater trochanter. After opening the canal a long guide wire was inserted in the canal to pass the fracture. An intramedullary nail was inserted, the nails that were used in this cohort were the Gamma 3 (Stryker®) and the Trochanteric Femoral Nail and Long Femoral Nail (Synthes®).

• Postoperative rehabilitation and follow-up

Immediate postoperative weight bearing is the standard of care. In the early postoperative phase protected weight bearing with crutches or a walker is advised and patients are allowed to bear weight as tolerated. In some cases the treating surgeon prescribed a period of 6 weeks non-weight bearing, mostly as precautionary measure in osteoporotic patients.

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 ‘loss to follow-up’.

• Data collection

All data was extracted from the electronic patient file and the available radiographs. From the files of all patients the following data was reviewed; operation report, daily clinical follow-up notes, discharge letter, all lab-results including microbiology, pre- and postoperative radiographs. In case of unclear medical follow-up notes the paramedic follow-up notes were also checked.

Radiographical union was defined as bridging callus on at least 3 of 4 cortices on AP en lateral radiographs. Lateral femoral wall displacement was measured on the first post-
operative AP radiograph (figure 3.). The difference in shaft-neck angle was measured on a weight bearing pelvic radiograph, at any point in time (figure 4.).

Operating time was derived from the operating theatre registration forms.

Trauma mechanism was coded as high vs. low energy trauma. High-energy trauma was assigned to patients that were victim in a motorised vehicle crash, fall from height >3m or pedestrian/cyclist hit by car >50km/h.

- **Outcome definition**

  The primary outcome measure is a composite measure defined as: ‘return to theatre for fixation failure at any time point, non-union or implant failure’, as was used in the study of Hoskins et al. (4). Secondary outcome measures were: 1. Deep infection, defined as return to theatre for infection. 2. Non-union at 12 months 3. Displacement of the lateral wall in mm 4. Duration of surgery 5. Change in femoral neck angle, defined as the difference between the shaft-neck angle between the operated and healthy side.

- **Statistical analysis**

  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 or frequencies for continuous and categorical data respectively. Chi-square tests were used to compare differences among categorical variables and student T-test for continues variables. P-values <0.05 are considered to be statistically significant.

4. **RESULTS**

In the period between January 1st 2006 and December 31st 2016 a total of 1070 patients were treated operatively in our hospital for a femoral fracture. One hundred forty-four fractures were in the subtrochanteric region. Twenty-seven patients were excluded because of pathologic fractures, segmental fractures, and open fractures or because of young age. Two patients died before the first postoperative radiograph could be taken and were excluded from further analysis.

In total 115 patients were available for analysis. Table 1. presents the demographic, trauma and operative factors of the patients. Sex was evenly distributed along the cerclage and no cerclage group. At present the standard of care for subtrochanteric fractures is a long nail,
however in 26% of the cases a short femoral nail was used for osteosynthesis, evenly distributed between the groups. There was a slightly higher proportion of high-energy trauma patients in the cerclage wire group, although this difference did not reach significance. There was a high proportion of patients lost to follow-up, with 49% en 48% there was no significant difference between both groups.

Comparison of the ‘cerclage’ and ‘no cerclage’ groups can be found in table 2. For our primary outcome measure there is no difference between the groups with a percentage of 4,3% in the cerclage as well as the no-cerclage group. In the cerclage group 2 patients had revision surgery for deep infection, none in the no-cerclage group. Due to the low incidence this difference did not reach significance. Non-union at 12 months was present in 14/46 (30%) of the group without cerclage and in 3/12 (25%) in the group with cerclage and also the time to union did not show a significant difference with 8,62 vs. 6,91 months until union respectively.

**Table 1. Demographics**

<table>
<thead>
<tr>
<th></th>
<th>No cerclage (n=92)</th>
<th>Cerclage (n=23)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>49% (45)</td>
<td>52% (12)</td>
<td>0.78</td>
</tr>
<tr>
<td>Long nail</td>
<td>74% (68)</td>
<td>74% (17)</td>
<td>1.0</td>
</tr>
<tr>
<td>High energy</td>
<td>77% (71)</td>
<td>87% (20)</td>
<td>0.30</td>
</tr>
<tr>
<td>Loss to follow-up</td>
<td>49% (45)</td>
<td>48% (11)</td>
<td>0.88</td>
</tr>
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</table>

The duration of surgery was significantly longer in the group who had cerclage wiring with 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 group without cerclage 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).
Table 2. Outcome measures

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

5. DISCUSSION

In this study we were not able to show a significant difference in return to theatre for implant failure 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 1. 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 (5–8). 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 was a large proportion of patients that is lost to follow-up, with very similar percentages between both groups. There are several explanations for the loss to follow-up, one of the most important factors is the mortality rate that can be as high as 26,8% in the first year (9). Besides the patients that die within the first year of follow-up there
was a large group of old and fragile patients. An important proportion of these older patients resided in a retirement/nursing home even before their fracture, or were admitted to a care facility after their fracture. It is challenging to get these older patients to the outpatient clinic for regular follow-up and often we will see that patients are followed by a doctor in their care facility but fail to have further follow-up in the outpatient clinic.

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% (5,8). On this basis we could hypothesize that there is indeed a group of patients that is lost to follow-up. On the other hand this might also be a reflection of the conservative approach at our institution. This is also reflected by the percentage of non-union at 12 months with 25% and 30.4% non-union in the cerclage and no-cerclage groups respectively. In the case of an asymptomatic non-union we did not advise patients to undergo revision surgery.

The duration of surgery was significantly longer in the cerclage group, a logical observation that is no different from other authors (10). The only major concern that we have with longer operating time is a theoretical higher chance of wound infection. Infection rates are in our study not significantly different between the two groups. There were twee deep infections in the no-cerclage group that required a re-intervention, in the cerclage group there was one superficial infection treated with a course of oral antibiotics.

Reduction was better when cerclage wire was used. In the cerclage group the displacement of the lateral wall was only 1.3mm as compared to 9mm 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. Both parameters of fracture reduction 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 (4,8,10).

The current general idea that placing cables or wires around the bone will cause ischemia arises from the communications of sir. John Charnley in 1950 who spoke of ‘the evil effects of the circumferential suture’ (11). 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. showed in a sheep model, the ischaemic zone underneath a cerclage cable is only 0.36mm wide (12). Furthermore, Apivatthakakul et al. 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 (13).

Other authors have shown promising results from the use of cerclage wire as an adjunct to intramedullary nailing. Hoskins et al. conducted a retrospective review of all subtrochanteric fractures at Royal Melbourne Hospital from July 2007 – January 2014. They included 134 cases, with a mean follow-up of 4 months. Closed reduction was satisfactory in 51,1%; open reduction without cerclage was used in 34,1% and open reduction with cerclage in 14,8%. No cases with cerclage wire had return to theatre, 7/46 open, 6/68 closed. (4) Kennedy et al. 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. Ban et al. reviewed 60 patients with subtrochanteric fractures that were treated in 2 Danish centres. In all patients cerclage was used as augmentation of the intramedullary nail. In total there were 4 reoperations, 1 due to deep infection, 1 due to technical failure during osteosynthesis, 1 had a screw cut out, and 1 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 (2). Shukla et al. reviewed 60 patients that were treated for a subtrochanteric fracture, 25 had a limited open reduction. They identified a malreduction (varus alignment) to be the most important factor in non-union. All three non-unions occurred in the ‘closed reduction group’, furthermore the hospital stay for patients with a malreduction was 26 days versus 16 days for patients with a neutral postoperative alignment. Afsari et al routinely used clamp-assisted reduction in 44 patients with a subtrochanteric fracture, in 9 an additional cerclage wire was used. All but one patient had union of their fracture within 6 months postoperatively, there were no infections. (14). The numerous clinical studies are also supported by a biomechanical study by Müller et al. who showed that cerclage wire application may substantially reduce the risk of osteosynthesis failure in complex fractures (15).

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 loss 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 union 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.

6. REFERENCES


13. Apivatthakakul T, Phaliphot J, Leuvitoonvechkit S. Percutaneous cerclage wiring, does


7. **SAMENVATTING**

Subtrochantaire fracturen zijn een subgroep van fracturen met een specifiek patroon van verplaatsing. Om deze verplaatsing tegen te gaan en een betere reductie te bekomen kan bij het gebruik van een intramedullaire nagel bijkomend een open reductie met cerclage worden uitgevoerd. Tegenstanders van deze techniek zijn van mening dat dit bijkomende weefselschade en ischemie van het periost veroorzaakt, hetgeen weer zou kunnen leiden tot meer non-union en hogere infectie ratio’s. Voorstanders argumenteren dat een anatomische reductie juist gunstig is om non-union te voorkomen.

In deze retrospectieve studie werden de postoperatieve resultaten van 115 patiënten met subtrochantaire fractuur vergeleken op basis van het al dan niet peroperatief gebruik van een cerclage draad.

De primaire uitkomstmaat was het uitvoeren van een revisie ingreep voor falen van de osteosynthese. Hierbij kon geen verschil tussen de groepen worden aangetoond. Er was ook geen significant verschil in infectie ratio.

De chirurgie duurde gemiddeld 28 minuten langer in de cerclage groep ($p=0.003$). De postoperatieve reductie was beter in de groep met cerclage. De verplaatsing van de laterale muur van het proximaal femur was gemiddeld 1,3mm wanneer cerclage werd gebruikt en 9mm wanneer geen cerclage werd gebruikt.

De studie heeft belangrijke limitaties als gevolg van zijn retrospectief karakter en 50% loss to follow-up. De resultaten liggen echter wel in lijn met resultaten van andere auteurs en we stellen dan ook dat open reductie en cerclage gebruikt kan worden indien gesloten geen bevredigende reductie kan worden bekomen.
Figure 1.
Figure 2.
Figure 3.