New insights in the treatment of femoral neck fractures

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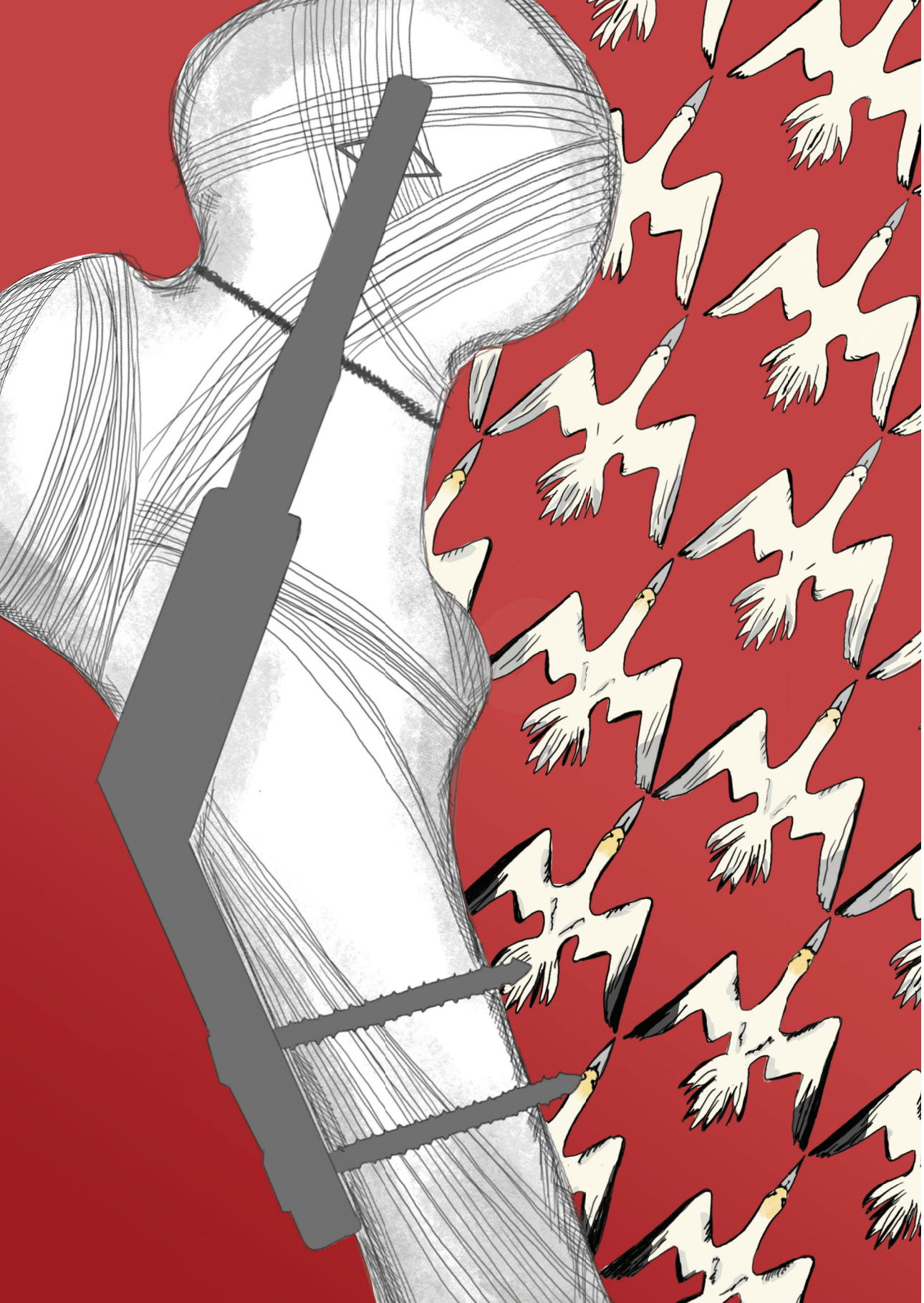

Chapter 9

Summary

The optimal treatment of Femoral Neck Fractures (FNFs) has been subject of debate for decades. A complex mix of patient, fracture and intervention-related factors determine the outcome of treatment. The overall aim of this thesis is to improve the treatment outcome of FNF surgery by identifying and, if possible, improving the factors that influence FNF healing.

IDENTIFY FACTORS THAT INFLUENCE OUTCOME OF TREATMENT OF FEMORAL NECK FRACTURES

Chapter 2 presents a systematic review that aims to provide an overview of predictors for failure of treatment of displaced FNFs (dFNFs) that were treated with internal fixation and quantify the risk of fixation failure in a meta-analysis. PubMed, Embase, Web of Science, Cochrane Library, and EMCare were searched for original studies published from January 2000, that included adult patients with an internally fixated dFNF and reported data on predictors for revision surgery due to non-union, avascular femoral head necrosis or cut-out of the implant. Univariable odds ratios (OR) for predictors of revision surgery were pooled using a random effects model. A total of 2348 articles were analysed resulting in the inclusion of 16 articles that met the inclusion criteria. These studies identified 24 potential predictors for revision surgery. Female sex (OR 1.78, 95% confidence interval (CI) 1.26–2.52), smoking (OR 3.64, 95% CI 1.68–7.91), age >50 years (OR 3.64, 95% CI 1.68–7.91), inadequate fracture reduction (OR 2.28, 95% CI 1.62–3.22), fixation with cannulated screws (CS) or pins compared to fixed angle devices (OR 2.16, 95% CI 1.03–4.54) were significant predictors for fixation failure. These factors have to be taken into consideration when deciding on the optimal treatment strategy.

One potential predictor for revision surgery in is thoroughly examined in **Chapters 3 and 4.** In **Chapter 3** we examined the correlation between the preoperative posterior tilt of the femoral head and revision surgery in patients with undisplaced FNFs (uFNFs). Posterior tilt was measured in 193 patients with a Garden type 1 and 2 FNF treated with the Dynamic Locking Blade Plate (DLBP). Results showed that patients that underwent revision surgery within the first year after the initial operation had a higher degree of posterior tilt prior to the surgical reduction and fixation compared to patients who had uneventful treatment: 21.4° and 13.8° of posterior tilt, respectively (p=0.03). The failure rate was 3.2% for uFNFs with a posterior tilt of less than 20° but increased to 12.5% for those with a posterior tilt of 20° or more. A posterior tilt of ≥ 20°was associated with an OR of 4.24 (95% CI 1.09–16.83; p=0.04). It appears that “stable” undisplaced, Garden type I and II FNFs with a significant posterior tilt (≥20°) in fact behave like unstable fractures. Therefore, posterior tilt ≥20° of the femoral head is a significant predictor for revision surgery of uFNFs treated with the DLBP. This finding suggests that a modified Garden Classification should be used to determine FNF displacement, incorporating posterior tilt as a factor.

To substantiate our results in **Chapter 3** we compared two measurements methods for posterior tilt of the femoral head for intra and inter observer reliability in **Chapter 4**. The Lateral Garden Angle (LGA) and the newer Posterior Tilt Measurement (PTM) were used to measure posterior tilt. Four observers measured the posterior tilt on the radiographs of 50 FNFs twice using both methods. The intra observer reliability for both methods is substantial, with an intra class coefficient of 0.75. The inter observer reliability of the PTM is substantial with an intra class coefficient of 0.75 compared to a moderate reliability of the LGA with an intraclass coefficient of 0.60. Based on these results, the PTM has a slight preference over the LGA for measuring the posterior tilt of the femoral head in uFNFs.

IMPROVING THE TREATMENT OF FEMORAL NECK FRACTURE SURGERY

The Dynamic Locking Blade Plate (DLBP), also known as 'the Gannet', has been used in Dutch hospitals for over a decade. The results of a small pilot study with 25 patients with an FNF treated with the DLBP were promising, with a failure rate of 8% at the two-year follow-up. In a prospective cohort of 172 patients with uFNFs, the failure rate was 4% at one-year follow-up. **Chapter 5** presents the first results of the DLBP in dFNFs in young patients. A multicentre prospective case series was conducted, including patients aged ≤ 60 years with a dFNF treated with the DLBP, with a follow-up of one year. The primary outcome parameter was revision surgery due to non-union, avascular necrosis of the femoral head (AVN) or cut-out of the implant. Out of the 106 consecutive included patients, 14 required revision surgery, resulting in a revision rate of 13.2% (95% CI 7.1–19.9). When compared to other implants in the literature, that show revision rates ranging from 18–48%, the DLBP appears to be the more favourable implant.

In **Chapter 6** we analysed the long-term results of the DLBP. A retrospective analysis was done of earlier collected prospective data. Revision surgery due to cut-out of the implant, AVN, non-union, or posttraumatic osteoarthritis (PTOA) was the main outcome parameter. Secondary outcome parameters were the indication for revision surgery, complications, time to revision surgery, rate of elective removal of the implant, potential predictors for revision surgery and mortality. The median follow-up of 389 patients included in the study was 98 months; 20.6% underwent revision surgery; 28.8% after treatment of a dFNF and 10.0% after a uFNF. Postoperative complications were observed in 10.5% (n=41) of the patients, and 32.9% (n=128) deceased during follow-up. The median time to revision surgery was 13 months for dFNFs and 18 months for uFNFs. 15.7% of the DLBPs were removed electively. In the multivariate Cox regression analysis, female gender (hazard ratio 2.1, 95% CI 1.2–3.7) and a Tip-Apex-Distance greater than 25 mm (hazard ratio 2.9, 95% CI 1.7–5) were significant predictors for revision surgery in patients with dFNFs. Although study popula-

tions differ throughout literature and are not exactly comparable to our patients cohort, the DLBP demonstrated positive long-term results in the treatment of FNF compared to other implants, with an overall revision rate of 28.8% versus 31.3–45.6% for dFNF, and 10.0% versus 10.7–19% for uFNF.

To prove this hypothesis the DEFENDD trial was designed. The study protocol is presented in **Chapter 7.** The aim of the DEFENDD trial is to compare the clinical outcomes and costs of dFNFs treated with internal fixation using either the DLBP or the Dynamic Hip Screw (DHS) in patients up to 65 years of age. The hypothesis is that the DLBP is superior compared to the DHS in terms of revision surgery rate, union rate, incidence of avascular necrosis and implant-related failure. This multicentre randomised controlled trial has a clinical follow-up of one year and questionnaires will be obtained for up to two years. The main outcome parameter is the incidence of revision surgery within one year, due to either non-union, avascular necrosis (AVN) or cut-out of the implant. Secondary study parameters include the incidence of avascular necrosis, non-union, (implant-related) complications, functional outcome, health-related quality of life, elective removal of the implant and treatment-related costs. The DEFENDD trial will provide high-level evidence on which implant is favourable for the treating dFNFs in young patients.

In **Chapter 8** the clinical implications are presented and discussed. The results in this thesis may assist surgeons in their daily practice and complement future treatment guidelines for FNFs. Further research should focus on the functional outcome of the DLBP, as well as factors that influence patient-related outcome measures. Additionally, decision aids should be developed to assist surgeons and patients in choosing the most optimal treatment for the patient with a femoral neck fracture.