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Risk factors for cut-out of double lag screw fixation in proximal femoral fractures

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ABSTRACT

Objective: We assessed factors associated with cut-out after internal fixation of proximal femoral fractures using double lag screw nails.
Design: Retrospective cohort study.
Setting: A university hospital.
Patients and methods: Patients with non-pathological intertrochanteric femur fractures and a minumum 90 days follow-up who underwent internal fixation with dual lag screw nails were included. Potential risk factors for lag screw cut-out investigated by our study were: age, gender, body mass index, comorbidities (American Society of Anesthesiologists [ASA] classification), type of fracture (AO/OTA classification), fracture stability, side, operation time, implant length, reduction quality, tip-apex distance (TAD), and lag screw configuration. Logistic regression was used to investigate potential predictors of screw cut-out.
Results: Eighty-five of the 118 patients with hip fractures treated between February 2010 and November 2013 at our institution met the inclusion criteria for the study. Fifty-eight patients were female (68.2%), mean age was 77.4 (range: 50–95 years), mean follow up was 380 days (range: 150 days-2.5 years), and cut of was observed in 9 patients (10.5%). The following variables identified through univariate analysis with $p < 0.2$ were included in multivariant logistic regression model: age, side, reduction quality, implant length, TAD and ASA score. Only TAD ($p = 0.003$) was found to be significant in the multivariant model.
Conclusions: Our study confirmed that risk factors for cut-out with single-lag screw devices are also applicable to dual-lag screw implants. We found that TAD was a significant factor for cut-out in dual-lag screw implants. Thus, screw cut-out can be minimized by optimizing screw position.

Introduction

Hip fractures commonly lead to high rates of morbidity, reduced life quality, and mortality [1]. Intertrochanteric hip fractures account for approximately half of all hip fractures in the elderly and the costs of care for this debilitating injury are a social and financial burden [2]. Cost of treatment increases steeply where complications occur and a previous study reported a 6.9% rate of complications requiring a second procedure [3].

Current treatment options of intertrochanteric fractures include cephalomedullary nails and compression dynamic hip screws [4]. Cephalomedullary nails are thought to be superior for the treatment of unstable intertrochanteric hip fractures with the theoretical advantage of improved fracture fixation biomechanics [5,6]. The use of both short and long cephalomedullary nails has been reported with positive clinical results [7]. Early nail designs were associated with a high rate of complications and reoperations, such that design modifications have been applied in recent versions [8]. Dual-lag systems were designed to improve rotational control and bony purchase within the femoral head, thus resisting cut-out and subsequent fixation failure [9]. The Veronail (Veronail Trochanteric System, Orthofix, Bussolengo, Italy) is a novel intramedullary (IM) device that enables double axis sliding or locked convergent fixation of the femoral head and enables treatment of the full range of pertrochanteric fractures with a single device. Two previous studies reported outcomes with this nail [10,11], but to the best of our knowledge, variables associated with cut-out have not been addressed before.

Cut-out is the most common cause of fixation failure with cephalomedullary nails and, in the literature, there is strong evidence that fracture type, reduction, and tip-apex distance (TAD) show associations with cut-out of lag screws from the femoral

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head [12–14]. Previous studies exploring mechanical and clinical factors for cut-out have used single-lag screw nails or dynamic hip screws. Additionally, there are concerns that the smaller diameter screws in dual-lag designs would be more prone to migration through the femoral head, thereby increasing the incidence of screw cut-out [15]. In contrast to these concerns, recent research has shown that double-screw designs provide equivalent or greater resistance against varus collapse and neck rotation in comparison with a single-lag screw implant [9,15]. However, there is still a paucity of literature concerning predictive factors for cut-out in dual-lag system implants.

The aim of this study was to assess factors that are associated with cut-out after internal fixation using the Veronail. In particular, we wanted to know if reduction quality and the TAD might affect the cut-out rate in fractures treated with Veronails.

Patients and methods

After approval by the local Ethics committee, all osteoporotic intertrochanteric fracture patients treated with Veronails in our institute between February 2010 and November 2013 were evaluated retrospectively ($n = 118$). Patient records were reviewed for age at the time of operation, gender, side of fracture, date of operation, date of final clinical follow-up, fracture stability, body mass index (BMI), reduction quality, and American Society of Anesthesiologists (ASA) scores. Exclusion criteria included pathological fracture and lack of radiological follow-up for at least 3 months post-operatively.

Both pre-operative and post-operative radiographs were reviewed by two of the authors present in the operations (KB and SI). Pre-operative radiographs were assesed to identify the type of fracture and fracture stability. The fractures were grouped into classes 31.A1, 31.A2, and 31.A3 based on the Orthopedic Trauma Association (OTA) classification [16]. Fractures were also grouped as stable (A1) or unstable (A2, A3). Immediate post-operative radiographs were used to measure the quality of the reduction and TAD with the use of a Picture Archiving and Communication System (PACS) (Centricity; General Electric Health Systems, Waukesha, WI, USA).

The patients were operated on within 3 days of admission. All patients received prophylactic low-molecular-weight heparin (LMWH) treatment. A single dose of antibiotics was administered within 30 min before surgery. Reduction and internal fixation were performed in the supine position on a fracture table using an image intensifier. From the first postoperative day, the patients were encouraged to walk with crutches. Patients with mild (ASA 1–2) or severe (ASA 3–5) systemic diseases were grouped using the ASA classification system.

Veronail has a design with a proximal diameter of 15 mm, distal diameter of 10 mm and lengths of 200 and 280 mm. This system allows alternative configuration of cephalic screws, with either two parallel sliding screws or two convergent screws locked to the nail. Lag screws were inserted as two parallel sliding screws in A1 fractures where the cephalic screws pass across the fracture line to permit controlled compaction. In A3 fractures, two converging screws were used where the cephalic screws do not pass the fracture line. A2 fractures were treated with both types of proximal fixation. In both configurations, screws were fixed to nails. Lag-screw diameter was 6.5 mm in the parallel configuration and 5.6 mm in the convergent configuration. Highly unstable and comminuted fractures were fixed with the 280 mm long Veronail system.

The TAD is the sum of the distance, in milimeters, from the tip of the screw to the apex of the femoral head, on the anteroposterior and lateral radiographs as described by Baumgartner et al. [12]. To assess TAD of the two screws in the AP view, we set a point in the middle between the tips of the two screws and measured the distance to the apex of the femoral head in both proximal fixation configurations [17]. In lateral view, TAD is determined as the distance between apex of femoral head and tip of proximal lag screw (Fig. 1). The apex of the femoral head is defined as the point of intersection between the subchondral bone and a line in the center of and parallel to the femoral neck.

The quality of the reduction was based on Baumgartner and Sembro [18,19]. Reduction was considered good when there was alignment (neck-shaft angle between 125° and 145° in the anteroposterior AP view and under 20° angulation on the lateral view) and the displacement of any fragment was 4 mm or less on either view. A reduction was categorized as good if both criteria were met, and moderate if only one criterion was met. Poor reductions met neither criteria. Assessment of reduction quality and TAD measurements were performed using the X-ray films that

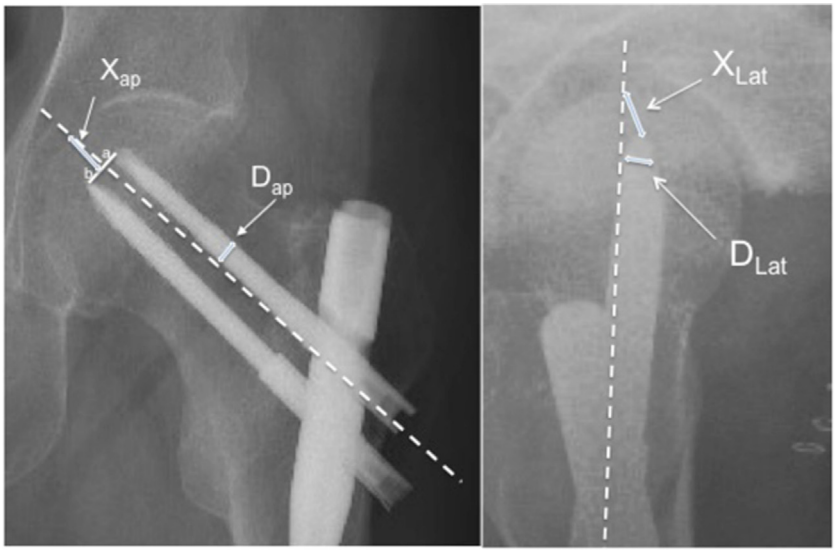

Fig. 1. In the AP view, to measure X_{ap} we set a point in the middle between the tips of the two screws and measured the distance to the apex of the femoral head. Measured diameter of the lag screw on an AP view is D_{ap}. In lateral view, to measure X_{lat} we set a point at the tip of screw and measured the distance to the apex of the femoral head. Measured diameter of the lag screw on an lateral view is D_{lat}.

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