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FAILURE OF INTERNAL FIXATION IN DISPLACED FEMORAL NECK FRACTURES: CLINICAL AND RADIOGRAPHIC CHARACTERISTICS AND OUTCOMES AFTER CONVERSION TO TOTAL HIP ARTHROPLASTY

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Abstract

Introduction: Internal fixation of displaced intracapsular femoral neck fractures may fail through nonunion, avascular necrosis, or mechanical complications. This study describes the clinical and radiographic characteristics of patients with failed fixation and reports quality-of-life outcomes after conversion to total hip arthroplasty.

Material and Methods: We retrospectively reviewed 28 patients (18 men, 10 women; age 40–65 years) treated between June 2018 and June 2023 at a single university trauma centre. All had initially undergone closed reduction and internal fixation for a displaced (Garden III–IV) femoral neck fracture and subsequently required revision for fixation-related complications. Radiographic bone quality, reduction quality, and cannulated-screw position were reviewed. All patients underwent hardware removal and conversion to total hip arthroplasty. Quality of life was assessed using the SF-36 before revision and during 12 months of follow-up.

Results: Eleven patients (39.3%) presented with avascular necrosis and 17 (60.7%) with nonunion or mechanical fixation failure. The Singh index at presentation was 4–6. All patients underwent conversion to total hip arthroplasty (21 uncemented and 7 cemented). In the avascular-necrosis subgroup, mean physical component summary score increased from 40.27 before revision to 52.27 at 12 months and mean mental component summary score from 40.45 to 54.72. In the nonunion/fixation-failure subgroup, the corresponding scores increased from 41.11 to 53.23 and from 42.05 to 54.00.

Conclusion: Failed internal fixation in this series frequently occurred despite relatively preserved radiographic bone quality and was commonly accompanied by suboptimal reduction and/or screw configuration. Conversion to total hip arthroplasty was associated with substantial improvement in patient-reported quality of life during the first postoperative year.

Keywords: femoral neck fracture; nonunion; avascular necrosis; internal fixation failure; conversion total hip arthroplasty; SF-36

Introduction

Internal fixation with cannulated screws remains the standard head-preserving treatment for many intracapsular femoral neck fractures, but it is not without a meaningful failure rate: nonunion and avascular necrosis of the femoral head are well-documented complications, particularly in displaced (Garden III–IV) fractures (1,2). Reported rates of these complications vary widely across the literature, from around 10% to over 30%, reflecting differences in patient selection, fracture pattern, surgical technique, and length of follow-up [1,3]. Meta-analyses comparing internal fixation with arthroplasty have consistently found higher reoperation rates after fixation of displaced fractures [4,5], and randomised evidence in young adults has identified posterior (dorsomedial) comminution, poor reduction, and improper screw placement — rather than surgical delay beyond 48 hours — as the principal determinants of nonunion and avascular necrosis after fixation [6]. A validated radiographic scoring system for cannulated-screw position, incorporating screw location in the femoral head, tip-to-articular-surface distance, calcar reference, screw–shaft angle, and axial-view position, has been used to quantify the technical adequacy of fixation and its relationship to healing [7].

Less well characterised is the specific clinical profile of patients in whom fixation fails despite treatment at a dedicated trauma unit, and the trajectory of quality of life once these patients are salvaged with arthroplasty. We reviewed a consecutive series of patients referred to our unit with a fixation-related complication after treatment of a displaced femoral neck fracture, characterised their bone quality and index-operation technical parameters where available, and report their functional recovery — measured with the SF-36 — after conversion to total hip arthroplasty.

Materials and Methods

Design and patients

This was a retrospective case series conducted at the University Clinic for Orthopaedic Surgery and Traumatology (TOARILUC), Faculty of Medicine, Ss. Cyril and Methodius University in Skopje, North Macedonia, forming part of a doctoral research programme on the surgical treatment of femoral neck fracture [8]. We identified 28 consecutive patients treated between June 2018 and June 2023 who had originally undergone closed reduction and internal fixation with cannulated screws for a displaced (Garden III–IV) femoral neck fracture and who subsequently presented with a fixation-related complication requiring revision surgery. All patients were aged 40–65 years (18 men, 10 women) at the time of the index injury. Clinical and radiographic data, including operative reports, radiographs and where available, computed tomography and magnetic resonance imaging obtained at the referring institution, were reviewed. The study was conducted in accordance with the Declaration of Helsinki, and patients consented to the use of their clinical data for research and to attend structured follow-up.

Definitions

Avascular necrosis was defined radiographically by subchondral sclerosis, segmental collapse of the femoral head with loss of sphericity or cystic change [9]. Nonunion was defined as persistence of the fracture line beyond six months with radiographic evidence of implant loosening, screw migration or cut-out, or varus deformity of the femoral head [6,7].



Figure 1. Representative radiographs of failed internal fixation of displaced femoral neck fractures: (A) nonunion with mechanical failure of fixation; (B) avascular necrosis of the femoral head following internal fixation.

Reduction quality at the index procedure was reconstructed where possible from archived radiographs using the Garden alignment index and a three-grade system (Grade I, satisfactory in both planes with posterior angulation <10°; Grade II, satisfactory in one plane only with posterior angulation <20°; Grade III, unsatisfactory in both planes with posterior angulation >20°) [10]. Bone quality was assessed on the presenting pelvic radiograph using the Singh index [11].

Surgical treatment

All patients underwent removal of the failed osteosynthesis material followed by conversion to total hip arthroplasty via an anterolateral (Watson-Jones) approach under spinal anesthesia. An uncemented stem was used where acetabular and femoral bone stock was preserved; a cemented stem was used where the acetabulum or proximal femur had been damaged by the failed hardware, or where significant osteoporosis was present. All patients received antibiotic prophylaxis for 5–7 days and

thromboprophylaxis for six weeks postoperatively, with physiotherapist-led mobilisation from the first postoperative day.

Outcome assessment

Quality of life was assessed with the physical (PCS) and mental (MCS) component summary scores of the SF-36 [12] immediately before revision surgery and at 6 weeks and 3, 6, and 12 months after revision, using the same structured protocol as a parallel prospective cohort at our institution [8].

Results

The 28 patients (18 men, 10 women) were aged 40–65 years at the time of the index fracture. All had sustained a displaced (Garden III or IV) femoral neck fracture and had been treated with closed reduction and internal fixation; the interval from injury to the index fixation ranged from 5 to 20 days. Eleven patients (39%) presented with avascular necrosis of the femoral head, and 17 (61%) presented with nonunion, radiographic loosening of the fixation construct, screw cut-out, or varus migration of the femoral head (Table 1).

Characteristic	**N = 28**
Sex, n	18 M / 10 F
Age range, years	40–65
Initial fracture grade (Garden III–IV), n	28 (100%)
Interval, injury to index fixation, days	5–20
Singh index at presentation	4–6
Avascular necrosis, n (%)	11 (39.3)
Nonunion / fixation failure / cut-out, n (%)	17 (60.7)
Conversion arthroplasty: uncemented THA, n	21
Conversion arthroplasty: cemented THA, n	7

Table 1. Characteristics of the 28 patients referred with failed internal fixation of a displaced femoral neck fracture. THA, total hip arthroplasty.

The Singh index at presentation was 4–6 in the great majority of patients, indicating mild or absent osteoporosis. Review of the available index radiographs showed that failures were commonly accompanied by an unsatisfactory (Grade II or III) reduction, radiographic dorsomedial comminution of the posterior femoral neck cortex, or a non-parallel or otherwise suboptimal cannulated-screw configuration. Because this series included only patients with failed fixation and no successfully treated comparison group, these observations are descriptive and do not establish independent risk factors for failure [6,7,10].

All 28 patients underwent conversion to total hip arthroplasty (21 uncemented, 7 cemented). Quality of life improved during follow-up (Table 2). In the subgroup presenting with avascular necrosis, mean PCS increased from 40.27 before revision to 52.27 at 12 months, and mean MCS increased from 40.45 to 54.72. In the subgroup presenting with nonunion or fixation failure, mean PCS increased from 41.11 to 53.23, and mean MCS increased from 42.05 to 54.00.

Subgroup	PCS, pre-revision → 12 months	MCS, pre-revision → 12 months
Avascular necrosis (n=11)	40.27 → 52.27	40.45 → 54.72
Nonunion / fixation failure (n=17)	41.11 → 53.23	42.05 → 54.00

Table 2. SF-36 physical (PCS) and mental (MCS) component summary scores before and 12 months after conversion total hip arthroplasty.

Discussion

This series characterises a clinically important population: patients whose internal fixation of a displaced femoral neck fracture failed and required conversion arthroplasty. The Singh index of 4–6 indicates that radiographic bone quality was relatively preserved in most patients. Suboptimal reduction, posterior comminution, and imperfect screw configuration were frequently observed among the failed cases. These findings are consistent with previously reported technical factors associated with nonunion after femoral neck fixation; however, the absence of a successfully fixed comparison group in the present study precludes estimation of their independent effect on failure risk [6,7]. Radiographic screw-position scoring systems such as that described by Schep et al. may provide an objective means of auditing technical quality at the index operation [7].

Following fixation failure, conversion to total hip arthroplasty was associated with improvement in both physical and mental quality-of-life scores during the first postoperative year. These findings support conversion arthroplasty as an effective salvage option after failed fixation. The choice between cemented and uncemented arthroplasty in this series was based on bone loss at the fixation site and the presence of osteoporosis; previous studies in fracture populations have reported differences in residual pain and periprosthetic fracture risk between fixation methods [14,15].

The observations from this series reinforce the importance of achieving and documenting satisfactory reduction and appropriate screw position during the index operation. When an acceptable reduction cannot be achieved, the choice of further fixation attempts or arthroplasty should be individualized according to patient age, fracture characteristics, bone quality, and clinical circumstances [6,7,10].

Limitations

This is a retrospective, single-arm case series without a contemporaneous comparison group of successfully fixed fractures, so it cannot establish the relative risk associated with individual technical factors, and the reconstruction of reduction grade and screw position from archived, sometimes externally obtained, radiographs is subject to measurement error. The modest sample size (28 patients) limits subgroup analysis, and outcome data were not available beyond 12 months, so longer-term implant survivorship after salvage arthroplasty could not be assessed. As in the companion prospective study, SF-36 is a subjective, patient-reported measure subject to recall bias.

Conclusion

Failure of internal fixation remains an important complication in the treatment of displaced femoral neck fractures and may result in nonunion, avascular necrosis, implant-related mechanical failure, and the need for subsequent reconstructive surgery. In the present series, fixation failure occurred in patients who generally demonstrated relatively preserved radiographic bone quality, while suboptimal fracture reduction and/or cannulated-screw configuration were frequently observed. Although the retrospective design and absence of a control group preclude establishing these technical parameters as independent risk factors, our findings emphasize the importance of achieving and documenting satisfactory fracture reduction and appropriate implant positioning during the index procedure.

Careful assessment of reduction quality using objective radiographic criteria, together with appropriate screw positioning and recognition of fracture characteristics that may compromise mechanical stability, should therefore form an integral part of surgical decision-making. In cases in

which stable anatomical reduction cannot be achieved, the potential benefits of continued attempts at head-preserving fixation should be weighed against the risk of subsequent failure and the possible need for revision surgery.

For patients in whom internal fixation had already failed, conversion to total hip arthroplasty provided an effective salvage treatment in this cohort. Substantial improvement in both the physical and mental components of health-related quality of life was observed during the first postoperative year in patients presenting with either avascular necrosis or nonunion/fixation failure. These findings support conversion total hip arthroplasty as a valuable reconstructive option following unsuccessful internal fixation of displaced femoral neck fractures.

An additional consideration in younger patients is that revision of a primary total hip arthroplasty is generally more complex than conversion to total hip arthroplasty following failed osteosynthesis. Therefore, preservation of the native femoral head by internal fixation remains an important treatment objective when satisfactory reduction and stable fixation can be achieved.

Overall, the results highlight two clinically relevant aspects of treatment: the importance of meticulous reduction and fixation at the initial operation and the potential for meaningful functional and quality-of-life recovery following conversion total hip arthroplasty when fixation fails. Larger prospective comparative studies with standardized assessment of reduction quality, implant positioning, fracture morphology, bone quality, and long-term patient-reported outcomes are needed to better define predictors of fixation failure and optimize the selection between head-preserving fixation and primary arthroplasty.

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List of abbreviations

AVN – avascular necrosis
CT – computed tomography
MCS – Mental Component Summary
MRI – magnetic resonance imaging
PCS – Physical Component Summary
SF-36 – 36-Item Short Form Health Survey
THA – total hip arthroplasty