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Segmental neck of femur fractures: A unique case report of an ipsilateral subcapital, greater trochanteric and intertrochanteric fracture and proposed management algorithm

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ABSTRACT

INTRODUCTION: Neck of femur fractures are now increasingly common in an ageing population. The management is well known and has been described in great detail. Concomitant ipsilateral segmental fractures of the neck of femur (SFNOF) however are rare and their investigation and management is poorly described.

PRESENTATION OF CASE: We present the surgical management of a unique and complex case of an ipsilateral subcapital, greater trochanteric and intertrochanteric fracture sustained in an 87-year-old female following a low trauma injury. This fracture configuration has not been described in the literature to date, neither has our method of reconstruction for this fracture, namely hemiarthorplasty, trochanteric stabilising plate and cerclage wires.

DISCUSSION: 15 cases from 1989 to 2011 managed by 8 different fixation devices and followed up for an average of 17 months (2–58 months). There was an initial mortality rate of 13% ($n=2$). All associated with low energy trauma occurred in female ($n=8$), and most with high energy trauma occurred in males (83%; $n=5$). The diagnosis was delayed or missed in 20% of cases, and the most common pattern was a concomitant undisplaced subcapital and intertrochanteric fracture (37.5%, $n=6$). The overall risk of avascular necrosis was 20%, with a greater risk in patients greater than 65 years of age (33%).

CONCLUSION: Ipsilateral SFNOF are rare injuries with a bimodal distribution, and carry a greater risk of AVN. We advise that all SFNOF should have pre-operative CT planning and propose an algorithm to treat these patients with a standardised surgical approach.

1. Introduction

Concomitant segmental fractures of the neck of femur (SFNOF) are rare and pose a challenge in surgical fixation. SFNOF occur in a bimodal distribution based on cases reported in the literature.[1–15] Generally, neck of femur (NOF) fractures in young patients often follow high energy trauma, with the elderly at added risk with low energy trauma in associated osteoporotic bone. The reported cases of SFNOF in the literature follow this pattern.

Furthermore, the reported risk of avascular necrosis (AVN) following intracapsular NOF fractures is about 1 in 5 risk of in those than 60 years of age, 12.5% in those aged 60–80 years and 2.5% for those aged more than 80 years.[19] We would predict SFNOF in both age groups would have a greater risk of AVN of the femoral head.

The main surgical consideration in the young is therefore the risk of AVN, whereas in the elderly this would be poor bone quality and potential fixation device failure.

In this article, we discuss the management of an 87-year-old lady with concomitant ipsilateral intertrochanteric, subcapital and greater trochanteric fracture. We have also reviewed the literature on the management of SNFOF and proposed a standardised strategy for pre-operative planning and surgical management.

2. Presentation of case

An 87-year-old lady was admitted to our emergency department following an episode of sudden loss of consciousness that caused her to fall at her nursing home residence. On presentation she had regained consciousness and complained of right hip pain, but was also found to be in fast atrial fibrillation. Her medical background included type II insulin-dependent Diabetes Mellitus, hypertension, Alzheimer's dementia and a previous NOF fracture treated with a Dynamic Hip Screw. Her medications included insulin, antihypertensive medication, and bisphosphonates once a

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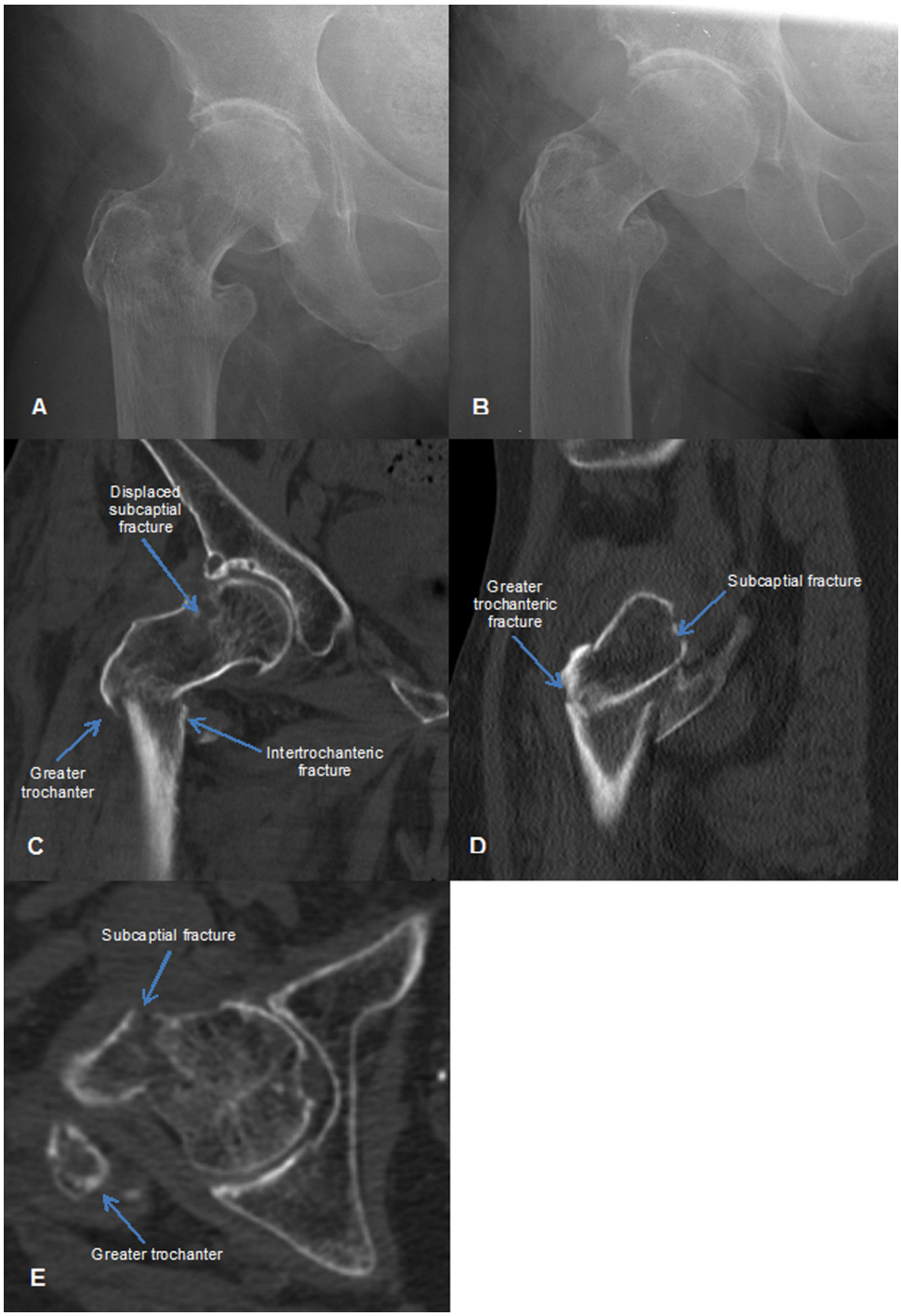

Fig. 1. A. AP X-ray, B. Oblique X-ray, C. Coronal view of displaced subcapital fracture and concomitant intertrochanteric fracture on CT D. Coronal view further posteriorly demonstrating greater trochanteric fracture on CT E. Displacement of supcapital fracture seen on axial view on CT.

week. Pre-operatively she mobilised using a Zimmer frame, and denied smoking or drinking any alcohol.

On clinical examination she had a tender right hip with a shortened and externally rotated leg. A plain antero-posterior (AP) radiograph and oblique view of the hip confirmed the presence of minimally displaced right subcapital and intertrochanteric fracture of the femoral neck. Due to the possibility of a greater trochanteric fracture, and to assess the degree of subcapital displacement a computed tomographic (CT) scan was performed (Fig. 1).

After careful pre-operative planning our patient underwent a cemented Exeter bipolar hemiarthroplasty (Exeter™ Trauma Stem) and fixation of the greater trochanter with a trochanteric cable grip device (Cable-Ready™ Cable Grip System by Zimmer). Due to her pre-morbid medical issues and intra-operative blood loss, our patient spent 4 days in High Dependency care, and due to her dementia and associated post-operative delirium mobilised minimally during rehabilitation. She was discharged to her nursing home 40 days post admission with a Vacuum Assisted Closure device due to a continuous serous wound discharge. At 12 weeks follow-up the wound had healed and she had improved mobility. A repeat X-ray showed a satisfactory position of the fracture (Fig. 2).

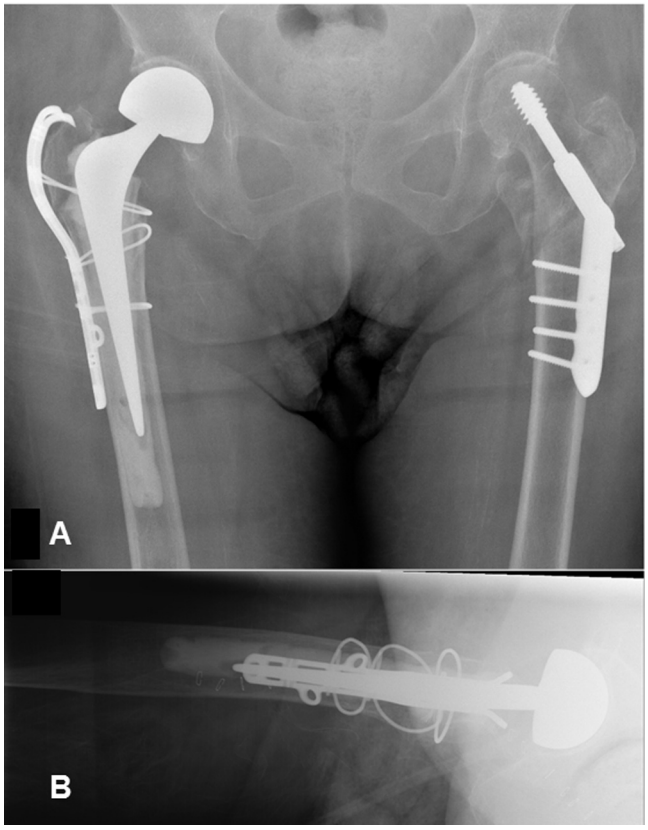

Fig. 2. 6 week post-operative X-rays of bipolar hemiarthroplasty and proximal femur plate fixation (A – Anteroposterior X-ray of pelvis, B – Lateral X-ray of right hip).

3. Discussion

SFNOF are rare and complex injuries caused by both low and high energy trauma in the elderly and young, respectively.[1–15] Our literature search yielded 15 cases from 1989 to 2011 (Table 1) managed by 8 different fixation devices and followed up for an average of 17 months (2–58 months). There was an overall mortality rate of 13% ($n = 2$). Our case is, to our knowledge, the first reported case of an ipsilateral subcapital, intertrochanteric and greater trochanteric fracture.

SFNOF occur in a bimodal age distribution and this is directly related to the injury mechanism. Incidence peaks in the mid-30s in high energy trauma, and mid-80s in low energy trauma (Fig. 3). Including our patient, 100% ($n = 8$) in the low energy group were female (2 were undefined). In the high energy group 83% were male ($n = 5$) and 17% were female ($n = 1$).

3.1. Investigations

Despite 12 patients (80%) being diagnosed with SFNOF on plain radiography, only 2 patients had CT scans (13.3%) and 1 patient had an MRI (6.7%) in their pre-operative work-up. 3 patients were identified by fluoroscopic examination intra-operatively[3,5] or post-operatively,[12] thus diagnosis was delayed or missed in 20% of cases.

The commonest association of femoral neck fractures is with ipsilateral femoral shaft fractures (incidence of 5–6%).[16] Including our patient, our literature review revealed 16 reported cases of SFNOF. The most common pattern was a concomitant subcapital and intertrochanteric fracture (37.5%, $n = 6$).

All the reported cases of a concomitant ipsilateral subcapital and intertrochanteric neck of femur fracture had non-displaced or minimally-displaced subcapital fractures, with displaced but stable

Table 1
Concomitant intra and extracapsular neck of femur fractures reported in the literature (THR: Total Hip Replacement; Hemi: Hemiarthroplasty; PCCP: Percutaneous Compression Plating; DHS: Dynamic Hip Screw; ARS: Anti-rotation screw; DCP: Dynamic Compression Plate; TSP: Trochanter Stabilising Plate; DCS: Dynamic Condylar Screw NA: not available; NR: not recorded).

Author/year	Age	Sex	Mechanism	Fracture type	Pre-op imaging	Implant used	Follow-up (months)	Outcome
Pemberton 1989[1]	73	F	Fall	Subcapital + basicervical	X-ray	DHS	30	Good
An 1989[2]	NA	NA	Fall	Intertrochanteric + neck	X-ray	Hemiarthroplasty with parham bands	NA	Good
Lawrence 1993[3]	Elderly	NA	Fall	Intertrochanteric + subcapital	X-ray	Pinning	2	Death-unrelated
Cohen 1999[4]	79	F	Fall	Peritrochanteric + subcapital	X-ray	DHS	24	Good
Yuzo 2001[5]	89	F	Fall	Neck + trochanter	X-ray, CT, MRI	Bipolar hemiarthroplasty	NA	Good
Kumar 2001[6]	83	F	Fall	Intertrochanteric + subcapital	X-ray	DHS + TSP+ ARS	12	AVN
Lakshmanan 2005[7]	91	F	Fall	Subcapital with extracapsular extension	X-ray	Hemiarthroplasty	6	Good
Sayegh 2005[8]	54	M	Crush injury (olive press)	Intertrochanteric + subcapital	X-ray	DHS and cerclage	58	Good
Poulter 2007[9]	76	F	Fall	Intertrochanteric + subcapital	X-ray	PCCP	4	Good
Butt 2007[10]	30	M	RTA	Neck + reverse oblique	X-ray	DHS + ARS	12	Good
Perry 2008[11]	86	F	Fall	Intertrochanteric + neck	X-ray	DHS	3	AVN
Dhar 2008[12]	30	M	RTA	T shape NOF	X-ray	DCP + lag screws	12	Good
Loupasis 2010[13]	36	M	RTA	Intertrochanteric + subcapital	X-ray	DHS + ARS	24	Good
Neogi 2011[14]	38	M	RTA	Neck and peritrochanteric	X-ray, CT	DCS + ARS	28	Good
Muzaffar 2011[15]	Mid-age	F	RTA	Transcervical, trochanter + shaft	X-ray	N/a	N/a	Death –polytrauma

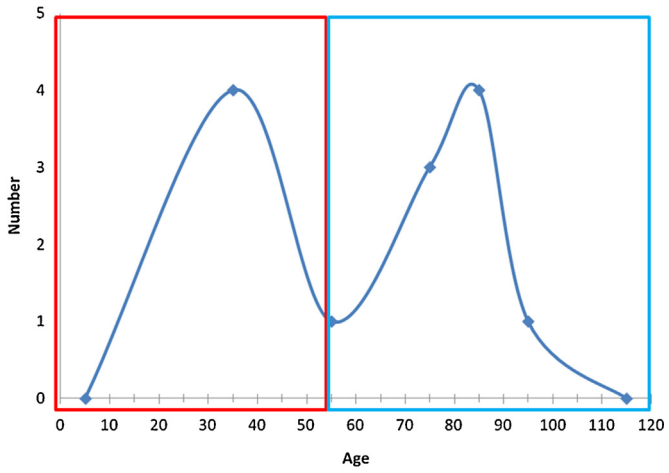

Fig. 3. The bimodal distribution of segmental NOF fractures (including our patient). The high energy (red) and low energy groups (sky blue) are demonsrated. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

trochanteric fractures. There have been no studies to demonstrate precisely how this fracture configuration arises, though it is postulated that the subcapital fracture could be the initial insult following impingement of the femoral neck against the acetabulum, with a secondary intertrochanteric fracture occurring if the initial excessive flexion or external rotational forces are not dissipated.[1]

3.2. Management

When approaching SFNOF, the objectives are to provide a stable construct whilst preserving the femoral head where possible. Typically, in intracapsular fractures of the femoral head, younger patients undergo DHS fixation to preserve the femoral head, whereas elderly patients undergo hemiarthroplasty due to the risk of AVN in what for many patients will be definitive surgery. In our literature review, SFNOF were managed by 8 different techniques. All patients younger than 65 all underwent a form of dynamic screw fixation, but two thirds of those older than 65 were managed by different forms of osteosynthesis ($n = 6$) and a third managed by hemiarthroplasty ($n = 3$). Specifically, subcapital and intertrochanteric fractures also lacked a standard approach. Generally speaking, 5 (71%) were managed by osteosynthesis and 2 (29%) by hemiarthroplasty. 50% ($n = 2$) of elderly patients managed by DHS subsequently developed AVN.

3.3. Risk of AVN

Perfusion to the adult femoral head predominantly comes from the lateral group of the ascending cervical branches of the extracapsular ring formed by the medial and lateral circumflex arteries.[17] Additional studies demonstrated a sub-synovial intra-articular arterial ring at the margin of the articular cartilage, from which epiphyseal arterial branches arise and enter the head of the femur.[18] These vessels are disrupted in subcapital fractures which may lead to AVN. A segmental fracture adds another layer of complexity in achieving satisfactory long term results, and increases the risk of AVN, with an overall risk of 20%, and 33% risk in patients greater than 65 years of age.

Our patient had a unique fracture configuration; a displaced subcapital element and concomitant intertrochanteric and greater trochanteric fracture. Following CT imaging to define the fracture accurately, we faced dilemmas in surgical planning. In the case of femoral head displacement, distraction was not feasible, and with the intertrochanteric element a hemiarthtoplasty alone was

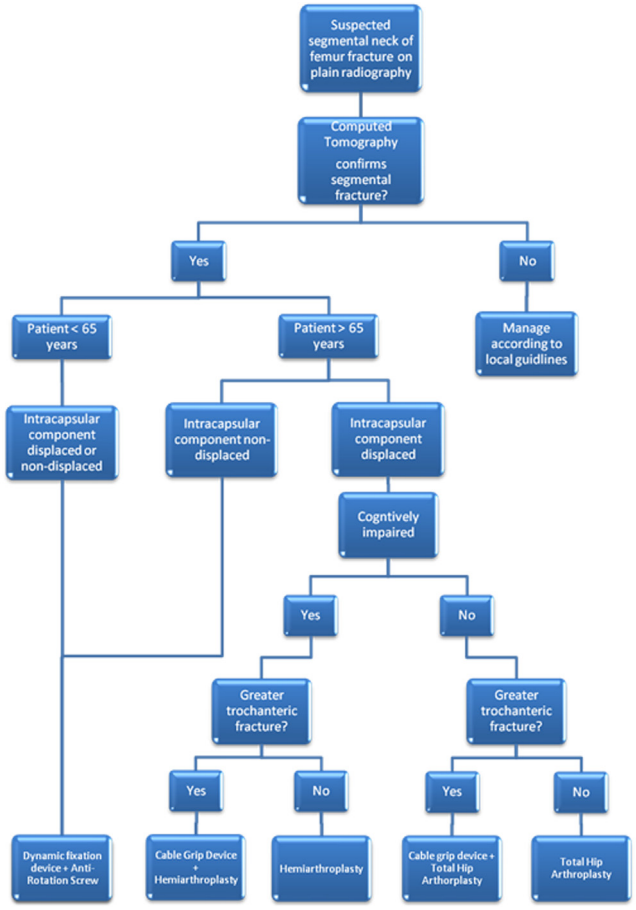

Fig. 4. Algorithm for the management of segmental neck of femur fractures.

not an option because of the lack of a stable femoral neck. With the medial buttress compromised, there was a risk of shortening, reduced offset and increased risk of prosthetic toggling leading to failure. An associated greater trochanteric fracture added another layer of complexity.

In cases of a concomitant undisplaced subcapital and intertrochanteric fractures in the elderly with follow-up, percutaneous compression Plates[9] and dynamic hips screws with anti-rotation screws[6,13] have been described. The dynamism is to cater for the intertrochanteric element, and anti-rotation screws to fix the subcapital injury. An advantage they state is the percutaneous nature of the surgery allows for a quicker procedure and post-operative recovery. However, a PCCP device cannot confer stability to injury patterns involving the greater trochanter, and fixation of this fracture is essential in post-operative hip abductor strength.[20] Trochanteric plating devices have been demonstrated to restore abductor mechanism, reduce the frequency and degree of pain and the functional disability.[20]

In our 87-year-old patient, we used a trochanteric cable grip device to fix the trochanteric fracture first. This enabled us to restore abductor function and the structural integrity of the base of the femoral neck. We then proceeded to a hemiarthroplasty due to the risk of AVN in displaced subcapital fractures. This is the first reported approach of this kind to this fracture pattern. Each patient should be considered separately, but we propose a standardised approach in the management of SFNOF (Fig. 4).

4. Conclusion

Ipsilateral SFNOF are rare injuries with a bimodal distribution, and carry a greater risk of AVN, with an overall risk of 20%, and

33% in those greater than 65 years of age. We advise that all SFNOF should have pre-operative CT planning and propose an algorithm to treat these patients with a standardised surgical approach.

Conflict of interest statement

None.

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None.

Ethical approval

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contributions

Mohammed Tahir: design, data collection, analysis and writing paper; Sandesh Lakkol: design, analysis and writing paper; Satyajit Naique: surgeon, design, data collection, analysis and writing paper.

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