Clinical Article

Management of intracapsular fractures of the hip in elderly patients

ND Naidoo MBChB, Dip PEC(SA), H Dip Orth(SA)
Registrar, Department of Orthopaedic Surgery, Nelson R Mandela School of Medicine, University of KwaZulu-Natal

Reprint requests:
Dr ND Naidoo
Department of Orthopaedic Surgery
University of KwaZulu-Natal
Nelson R Mandela School of Medicine
Private Bag X7
Congella
4013
Tel: (031) 260-4297
Fax: (031) 260-4518
Email: naven33@webmail.co.za

Abstract
Intracapsular fractures of the neck of femur in the elderly patient population results in an enormous economic and social burden. The aim of this paper is to present a review of the literature providing guidelines for the management of this common fracture with emphasis on patient selection, optimisation and preventative strategies.

Introduction
Fractures of the neck of the femur are common in the elderly with the estimated incidence of 80 per 100 000 in the United States.[1] It has been reported by Koval and Zuckerman that more than 250 000 hip fractures are recorded in the USA annually with an anticipated doubling of this figure by 2050.[2,3] The annual cost of these injuries has been estimated at $8.7 billion in the US and £726 million in the UK.[4] The incidence in South Africa has not been investigated.

Vascular anatomy
The vascular anatomy demands attention as it is this factor that plays a major role in the management and outcome of patients with these fractures. The blood supply to the femoral head was initially described by Crock who divided it into three major groups, i.e. the extracapsular arterial ring at the base of the femoral neck, ascending cervical branches of the arterial ring on the surface of the femoral neck and arteries of the ligamentum teres[5] *(Figure 1a)*. The majority of the femoral head's blood supply is derived from the lateral epiphyseal artery *(Figure 1b)*.[6]

The inferior metaphyseal artery is the terminal branch of the ascending portion of the lateral femoral circumflex artery and supplies the more distant metaphyseal bone anteriorly. The medial epiphyseal artery of the ligamentum teres supplies only the perifoveolar region.[7]

Pathogenesis
Displacement correlates with the extent of damage to the vascular supply with disruption of the lateral epiphyseal and medial circumflex vessels and results in only 20% of femoral heads retaining blood supply by collaterals that maintained viability.[8] Kinking of the vessels reinforces the argument for early anatomical reduction as this will enable revascularisation of the head, reducing the incidence of osteonecrosis; however, this is controversial.[9] Intracapsular fractures are exposed to synovial fluid that interferes with the healing process. Angiogenic inhibiting factors in synovial fluid play a role in inhibition of repair.[10] Femoral neck fractures have been shown to disrupt the vascular supply to the femoral head in studies incorporating histological and injection techniques.[11-13]

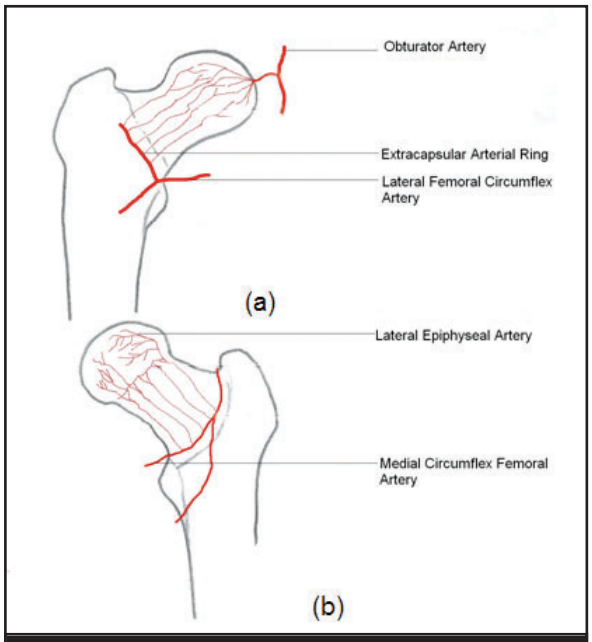

Figure 1: Femoral head blood supply

The presence of intracapsular haematoma results in high intracapsular pressures leading to occlusion of venous outflow and compromised arterial inflow. This phenomenon holds true where the joint capsule remains intact.[14] Aitken, in his study of 195 females with hip fractures, showed that 16% did not have osteoporosis and that intracapsular fractures were more common in females without osteoporosis. Females with osteoporosis were noted to sustain intertrochanteric fractures more commonly when compared with a control population of similar mass measurements.[15] Wong *et al* studied the effect of age on bone composition and osteocyte viability in femoral heads from 51 subjects and showed that bone volume and content of calcium and phosphorous decreases with age and that osteocyte viability decreases to a mean of 74% in the eighth decade.[16]

Classification

The Garden classification is the most widely utilised system but is subject to inter- and intra-observer errors resulting in these fractures being commonly classified as undisplaced (Garden I and II) and displaced (Garden III and IV)[17] *(Figure 2)*. Frandsen showed that only 22 of 100 fractures were classified identically by eight observers. There was also disagreement on displacement in 33%.[18]

The Garden classification is the most widely utilised system but is subject to inter- and intra-observer errors

Pauwels classification is based on the angle the fracture line forms with the horizontal plane and relates the fracture line to shearing forces. The classification neglects the important coronal plane and its reproducibility depends on a consistent radiographic protocol.[19]

Clinical presentation

Patients are elderly, often with delayed presentation due to poor social circumstances. Multiple co-morbidities with poor control may exist that require concomitant attention including medical, surgical, oncological and psychiatric. Inadequate nutrition resulting from a poor diet is often a presenting feature in this group of patients.

Diagnostic investigations

Plain X-rays will, in the majority of patients, provide conclusive evidence of the fracture. There are patients in which suspicion exists and plain radiographs are not helpful, e.g. stress or impacted fractures.[20]

Technetium-99m methylene disphosphonate is 80% sensitive for fractures in the first 24 hours, 95% in three days, with maximal sensitivity at seven days. It may also be utilised as a prognostic indicator for future fracture redisplacement, and non-union or segmental femoral head collapse in femoral heads that demonstrate reduced uptake post surgery.[21]

The advent of 3-D reconstructions and reconstructed images in the orthogonal planes have improved the degree of confidence where axial fractures in the plane of images were missed in uncertain or occult fractures.[20]

MRI is sensitive and specific in the detection of occult femoral neck fractures due to its ability to show the fracture and bone marrow oedema.

It is currently the best imaging modality for detecting femoral neck fractures.[20]

Management

Non-operative management

Non-operative management may be considered in patients who present an unacceptable anaesthetic risk.[22] Non-ambulators may also be considered as well as patients who refuse surgery. Management encompasses prolonged non-weight bearing. The complications with this form of treatment are associated with immobilisation and include pressure ulcers, hypostatic pneumonia, deep vein thrombosis, pulmonary embolism, urinary tract infection, bowel dysfunction and joint stiffness. The process of management incorporates bed rest and mobilisation when pain allows.[23]

Intensive nursing and medical care is required in the initial phase to ensure respiratory competence and prevention of bed sores and DVT. A multidisciplinary team approach is required with involvement of the occupational therapist, physiotherapist, psychologist and physician.

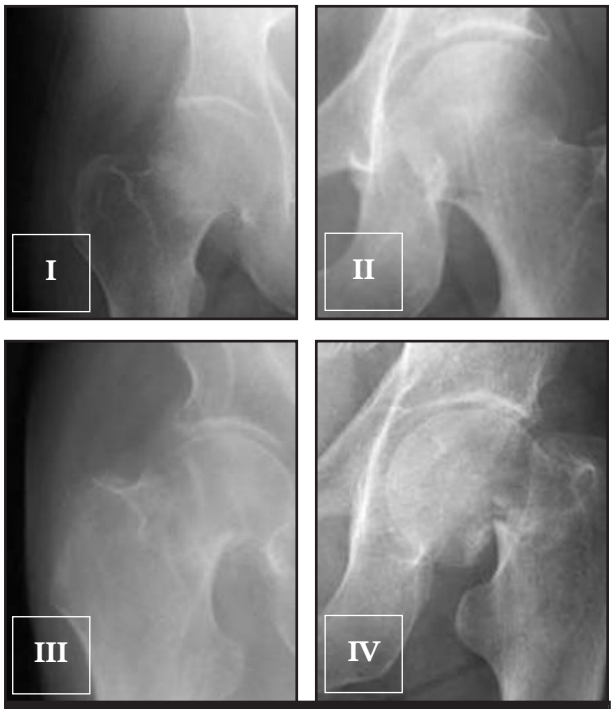

Figure 2: Garden classification

Harper and Greg demonstrated that none of their patients managed non-operatively became independent walkers.[23] Hornby *et al* showed that patients were less independent after 6 months than those who were operated on.[24] Heim *et al* demonstrated that 50-60% gained full ambulatory status and 10-15% became home ambulators.[22] Mobilisation was initiated after six weeks of immobilisation.

Operative

Clinical assessment

The initial clinical assessment should be meticulous in order to identify co-morbidities and assess their extent. The patient's presenting condition has a bearing on the management course and is therefore paramount.

Investigations should include haematological tests such as a full blood count, urea and electrolytes, liver function tests and random blood glucose. Cardiovascular and respiratory investigations should include an ECG, echocardiogram, chest X-ray and pulmonary function tests.

Initial interventions

Oxygen therapy should be initiated in patients with poor pre-operative oxygen saturation as these patients continue with poor saturation in the postoperative phase.[25] Patients should have pulse oximetry monitoring from admission to 48 hours post surgery as post hip surgery desaturation may persist for up to two days.[25,26] Fluid therapy should be judicious, goal-directed and appropriate. Correction of biochemical parameters must be initiated.

Numerous studies have shown no benefit with pre-operative skin traction.[27-29] Prevention of pressure sores is achieved by nursing on a pressure relieving mattress.[30,31]

Thromboprophylaxis should be initiated in patients. Mechanical prophylaxis in the form of pressure graded stockings should be applied soon after admission. Low molecular weight heparin therapy, unfractionated heparin therapy and pentasaccharides have been advocated as chemical prophylaxis.[32-34] Aspirin has been shown to have no effect on mortality with a substantial increase in post-operative bleeding complications in hip fracture patients.[34] Mechanical devices may be utilised in conjunction with chemical prophylaxis or in patients who have contraindications to anticoagulants and antiplatelet agents.[35-37] The choice of pre- and post-operative prophylaxis is individualised and base on available resources, patient compliance and drug safety and efficacy.[34] A pre-operative medical assessment should be expedited.

Anaesthesia

Regional anaesthesia is the method of choice for most patients with its weak thromboprophylactic effect and the use of new strategies to combat hypotension.[34,38,39] Combined spinal epidurals are currently advocated as they provide the option of postoperative analgesia.[40] Regional anaesthesia is associated with reduced rates of postoperative confusion (9.4%) when compared with general anaesthesia (19.2%). There is currently insufficient evidence to rule out clinically important differences between regional and general anaesthesia.[40]

Prophylactic antibiotics

Antibiotics should be administered 30-60 minutes before the incision.

Cefazolin, a first generation cephalosporin, is the agent of choice. It has a narrower spectrum of activity than higher generation cephalosporins and includes better *Staphylococcus aureus* cover. It is inexpensive when compared to the higher generations and possesses a moderately long serum half-life suitable for prophylaxis.[41]

Administration should not exceed 24 hours postoperatively where no further indication for appropriate antibiotic therapy exists.

Undisplaced fractures

There is general acceptance that displacement of the femoral fracture correlates well with postoperative complications and outcomes.

Tidermark showed a 33% complication rate in displaced fractures vs 7% in undisplaced fractures.[42] Screw fixation is the most commonly utilised method of stabilisation for this group of patients. Three cannulated screws placed parallel with the threads crossing the fracture line to enable compression is the current fixation of choice with the addition of a fourth screw in fractures with posterior comminution.

Screw configuration is controversial with various orientations being utilised.[43] The screws should make purchase with subchondral bone. Posterior and inferior placed screws are placed to prevent posterior and varus displacements.[44] Joint aspiration has been advocated to reduce intracapsular pressures thereby improving blood supply to the femoral head.[45] Stromqvist *et al* showed intracapsular pressure varying from 0-360 mmHg in 50 patients with subcapital fractures of the neck of femur Garden I and II. There is currently insufficient evidence to support anterior capsulotomy.[21] Special consideration should be given to patients with metabolic bone disease and chronic renal failure as they have a higher risk of complications following internal fixation. Arthroplasty should be considered in this group.[43] Complications include non-union, avascular necrosis, infection, hip penetration by screws, as well as chronic pain.

Displaced fractures

It is within this subset of fractures that debate has continued to rage regarding the methods of surgical management.[44,46-56] It is regarded as largely unresolved dilemma but a fair volume of evidence is available to guide the surgeon in pre-operative planning. The most important determinant is the patient and his/her clinical presentation, followed by surgeon experience and economic constraints. The surgical options include fixation or arthroplasty either cemented or uncemented, unipolar or bipolar, and total hip replacement.

Fixation

Limited indications exist for this type of management in the elderly. If attempted, surgery should be performed within six hours of injury. In patients who posed a greater anaesthetic risk by virtue of their general condition and co-morbidities, Bosch *et al* utilised fixation as their surgical method of choice irrespective of time from injury.[46,47,57]

Fracture reduction may be obtained with the use of a traction table and image control or manoeuvres such as the Leadbetter manoeuvre.[43,58] The Garden alignment index is utilised to assess the quality of reduction.[59] Weintrobe *et al* demonstrated that non-anatomic reduction of the fracture was the strongest predictor of fixation failure.[60] Inferior offset and varus angulation were described as being the major deformities implicated.[61]

Open reduction is indicated in young patients (< 60 yrs) through an anterolateral Watson Jones approach.[43] Implants include AO cannulated screws. Dynamic hip screws have been utilised with derotation screws to eliminate rotational deformities but have demonstrated poor torsional stability.[48] Various other screw types and devices are currently in use including the Manninger, Garden and von Bohr screws as well as the Harrison hook pin.[44] Patranen, utilising three cannulated hip screws, and Heikkinen utilising hook pins, have shown that their patient study groups had lower mortality rates and better function in the over 80-yr group.[49,50]

The majority of published data provide a contrasting picture with a revision rate of 5% to 30% resulting in secondary arthroplasty.[44]

Arthroplasty

Arthroplasty is recommended over fixation for patients over 70 years with displaced fractures.[51] Despite the advantages of shorter operating time, decreased blood loss and reduced length of hospital stay in the fixation group, the disadvantages associated with pain, loss of fixation and reduction, avascular necrosis, non-union and a high re-operation rate has made arthroplasty a more attractive option.[43] A randomised trial demonstrated no difference in mortality and a higher failure rate with poorer outcomes for patients undergoing fixation.[62] A meta analysis by Bhandari demonstrated that non-randomised trials overestimated the mortality rate associated with arthroplasty. The study demonstrated that re-operation rates are reduced in patients undergoing arthroplasty and that there still exists some evidence for increased mortality rate, operation time and infection associated with arthroplasty.[63] Iorio through various economic models showed that arthroplasty remains the most cost effective option for neck of femur fracture.[52] A randomised trial on cognitive impairment showed no difference in mortality or morbidity in patients with severe cognitive impairment vs patients with normal mental status.[53] Where death was envisioned prior to implant failure, fixation is considered by many authors.[43] Cemented prosthesis is the current standard with uncemented implants gaining popularity. There has been no evidence to suggest increased mortality.[64,65]

Cemented unipolar implants have demonstrated a reduced incidence of thigh pain and better patient mobility in some studies but this is yet to be resolved by well controlled prospective studies.[52] Kenzora suggested better function and pain relief with bipolar prosthesis.[54] These results appear to be isolated as the balance of available literature shows no difference between unipolar and bipolar implants.[55,56,66] Theoretically, the bipolar prosthesis has a reduced incidence of dislocation and acetabular wear and is easier to revise to total hip replacement.[61]

Total hip replacement

Total hip replacement (THR) has been advocated as a treatment option in this group of patients but should be limited to a specific cohort of patients. Patients with pre-existing acetabular disease fulfil the indication for THR. Johannsson suggested THR for all patients >75 years with a normal mental state and high functional demand.[67] Other indications include contralateral hip disease, life expectancy of 5 to 10 years, and metastatic disease. Tidermark showed markedly reduced complication rates for THR (4%) as well as reduced re-operation rates.[42] A 13-year follow-up demonstrated lower revision rates for total joint arthroplasty vs internal fixation and hemi-arthroplasty.[68]

Evidence to the contrary exists. Burns showed no benefit of THR after 1 year.[69] Dislocation rates varied from 0-16%.[44]

Rodriguez-Merchan showed preliminary results of THR post intracapsular fracture to be comparable with elective THR and hemi-arthroplasty.[61]

Post-operative management

A multidisciplinary approach is indicated with high care unit management being ideal. Careful titration of opiates for analgesia is necessary due to poor renal function. Transfusion should not be administered for asymptomatic patients with an Hb <8 g/dl.[70] Indwelling catheters should be avoided where possible, and intermittent catheterisation should be performed where urinary retention occurs as this has been shown to have a reduced incidence of infectious complications.[71] Nasogastric feeds may be initiated postoperatively and oral supplements may be continued for six months post surgery.[72] Mobilisation should begin 48 hours post surgery. Co-ordinated inpatient and outpatient protocols should be devised for the rehabilitation of patients.[73]

Outcomes

The Cochrane review has highlighted the paucity of well-controlled studies in this domain. No statistically significant differences were noted in outcomes of patients when comparing cemented and uncemented prostheses, unipolar vs bipolar, uncemented hemi-arthroplasty vs THR and cemented hemi-arthroplasty vs THR. Despite this, the review concludes that no definitive conclusions can be drawn.[74]

Fall prevention strategies include behaviour, attitude, medication use and footwear modification, as well as home hazard reduction

In a comparison of two centres Keene *et al* showed that 34% of patients died in the first year in a study population of 1 522. Male sex, institutional residence, age and increased dependency on walking aids were some of the factors associated with increased mortality.[75]

Holmberg showed in a 6-year follow-up that patients admitted from institutions had a higher mortality rate (84%) compared to a mortality rate of 46% in patients admitted from home.[76]

The POSSUM score has been utilised as a predictive tool in respect of mortality and encompasses physiological, biochemical and radiographic parameters.[77]

Prevention

Implementation of fall prevention strategies in multi-community studies have demonstrated a significant decrease in falls in elderly patients. Strategies included behaviour, attitude, medication use and footwear modification as well as home hazard reduction. Information was disseminated via media, pamphlets, brochures and local health care workers.[78] Bone mineral density (BMD) measurements have been shown to be useful as a predictive tool in femoral neck fractures. Low areal BMD, cross-sectional moment of inertia, cortical thickness and high buckling ratio are associated with a higher risk of hip fracture.[79]

Focused individual risk factor modification has proved to be more effective than interventions targeting multiple risk factors or unselected groups.[80] Diagnosis and management of osteoporosis is important in preventing subsequent fractures in these patients. Bisphosphonates (aledronate, risedronate), oestrogen replacement therapy, strontium ranelate and vitamin D + calcium are noted to have convincing evidence of antifracture efficacy in osteoporotic hip fractures.[81]

Conclusions

The management of intracapsular fractures in the elderly patient is complicated by the numerous patient factors that have been highlighted. Surgical options are dictated by patient and fracture personality.

Due to the global increased longevity of patients and the lack of data in South Africa, multicentre studies in this country are necessary to evaluate the economic impact of these injuries and strategies on management.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article. This research was not submitted to an ethical committee. This article is free of plagiarism.

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