



Retrograde cement arteriovenogram of nutrient vessels following hemiarthroplasty of the hip

Lushun WANG, Antony Westwood GARDNER, Ernest Beng Kee KWEK, Ganesan Rajamoney NAIDU

From Tan Tock Seng Hospital, Singapore

Retrograde cement extrusion into the nutrient vessels of the femur is a rare phenomenon in uncomplicated cemented hemiarthroplasty of the hip ; this is a report on three cases.

Routine postoperative radiographs showed a continuous dense linear opacity arising from the posterior medial region of the femur. Computed tomography (CT) scans revealed no evidence of a cortical break in the femur and confirmed our suspicion of retrograde cement extrusion into the nutrient vessels of the femur. Post-operative recovery was uneventful with no complications of cement thromboembolism.

Our findings in three cases suggest that cement retrograde extrusion into nutrient vessels following hemiarthroplasty is a benign complication of modern cementing techniques involving pressurisation. The site of cement extrusion into the nutrient foramina displays a constant topography.

We recommend that a CT scan of the femur be done on detection of a radio-opaque density on post-operative radiographs to differentiate an extra-osseous breach from an intra-vascular extrusion of cement. The theoretical complications of cement embolism and thrombosis should be kept in mind and looked for clinically.

Keywords : hemiarthroplasty ; total hip arthroplasty ; polymethylmethacrylate cement ; nutrient artery ; nutrient vein.

INTRODUCTION

Modern cementing techniques during hip arthroplasty involve the pressurisation of cement to allow

better cement interdigitation with bone for a better interlocking fit. This increases the interfacial shear strength between the bone and cement (1,5) with the aim of maximising the longevity of the prosthesis. The reported forces generated by cement compression during total hip arthroplasty reach peak pressures that varied between 122 kPa and more than 1500 kPa (3). The high intramedullary pressures encountered can in rare cases, lead to extrusion of cement through the nutrient foramina in the femoral cortex, and into the nutrient vessels, thus producing a retrograde arteriovenogram.

PATIENTS AND METHODS

The hip hemiarthroplasty database of our department was reviewed. We found three cases where retrograde cement arteriovenograms of the nutrient vessel were created. We present the clinical data as an illustration and

-
- Lushun Wang, MRCS (Edin), Specialist Registrar.
 - Antony Westwood Gardner, MRCS (Eng), Specialist Registrar.
 - Ernest Beng Kee Kwek, FRCS (Edin) (Ortho), Consultant.
 - Ganesan Naidu Rajamoney, FRCS (Edin) (Ortho), Consultant.
- Department of Orthopaedics, Tan Tock Seng Hospital, Singapore.*

Correspondence : Dr Wang Lushun, Department of Orthopaedics, Tan Tock Seng Hospital, 11 Jalan Tan Tock Seng, Singapore 308433. E-mail : kaedetod@gmail.com

© 2012, Acta Orthopædica Belgica.

analyse the relevant literature to identify similarity and potential clinical implications for further cases.

Case 1

An 84-year-old Indian lady was admitted for a displaced right femoral neck fracture after an accidental fall. She had a past medical history of type 2 diabetes mellitus, hypertension and peripheral vascular disease.

She underwent an uncomplicated cemented right bipolar hemiarthroplasty. Third generation cementing techniques were employed. The femur cavity was prepared after reaming by using an intramedullary brush and pulsatile saline lavage. A cement restrictor was then inserted 2 cm distal to the tip of the femur implant. Cement (Palacos®) was injected into the femoral canal using a cement gun at the 3-minute mark and pressurised with a wedge device. Finally the prosthesis (Zimmer Heritage size 11) was inserted at the 5-minute mark. There were no intra-operative complications noted.

Post-operatively, the patient made an uneventful recovery. The post operative radiographs showed a radio-opaque density consistent with cement arising from the postero-medial aspect of the femur shaft 155 mm distal from the tip of the greater trochanter. A computed tomography (CT) scan of the right femur showed a continuous linear column of cement extending from within the intramedullary canal to the nutrient foramina via the posterior cortex of the femur with no cortical perforation. This density was of uniform calibre initially with no appearance of valvular constriction before cement extravasation (Fig. 1). This suggests an iatrogenic cement retrograde arteriogram.

Case 2

A 77-year-old Chinese lady with a medical history of mitral valve prolapse, hypertension and hyperlipidaemia was admitted with a displaced left femoral neck fracture after an accidental trip and fall.

She underwent a left cemented bipolar hemiarthroplasty. The femoral canal was prepared similarly to the previous case with 3rd generation cementing techniques applied. Cement (Stryker Simplex® P Tobramycin) was pressurized into the femoral canal again at the 3-minute mark. The prosthesis (Zimmer Versys size 11) was inserted again when cement became doughy at the 5-minute mark. The patient's vital signs remained stable intra-operatively.

Routine post-operative radiographs showed a continuous column of dense material extruding from the poste-



Fig. 1. — The post-operative (B) radiograph in this patient after a right hip hemiarthroplasty showed a radio-opaque density consistent with cement arising from the medial femur shaft not evident in the pre-operative films (A). A computed tomography (CT) scan (C, D) of the right femur showed a continuous linear column of cement extending from the intramedullary canal to the nutrient artery via the posterior cortex of the femur. This density was of uniform calibre initially before extravasation suggesting a cement retrograde arteriogram.

rior-medial border of the femur. The site of cement extrusion was measured to be 138 mm distal to the greater trochanter. The point of cement communication with the femur was consistent with the normal position of the nutrient foramen and the appearance of valvular constrictions at the start of the density suggested a retrograde cement venogram of the nutrient vein. The calibre of the density then increased significantly, thus suggesting an extravasation of cement into the soft tissues (Fig. 2). The patient recovered well with no post operative complications.



Fig. 2. — A continuous column of dense material extruding from the posterior-medial border of the femur is shown on the radiographs post hemiarthroplasty (B, D) again not evident on pre-operative films (A, C). The presence of valvular like constrictions in the cement extrusion suggests the creation of a retrograde cement venogram.

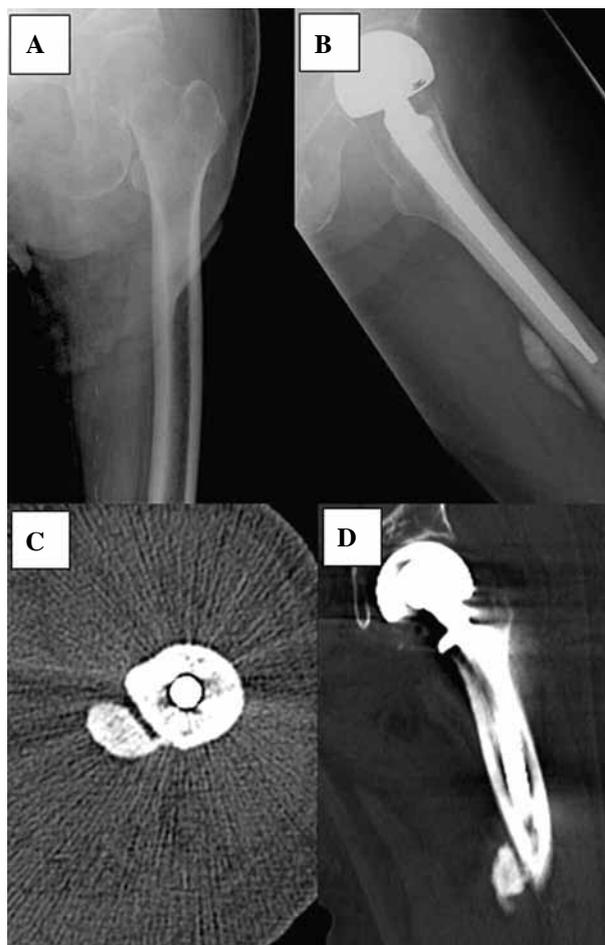


Fig. 3. — A worrisome collection of cement was noted on post-operative radiographs (B) in this patient who underwent hemiarthroplasty of the left hip. Subsequent computed scanning (C, D) revealed an intact femur shaft with the neck of cement extrusion from the nutrient foramina clearly demarcated.

Case 3

A 71-year-old Chinese lady was treated for a displaced femoral neck fracture after a fall with a cemented bipolar hemiarthroplasty. She had a medical history of hypertension, surgically treated breast carcinoma and vascular dementia.

Cement (Stryker Simplex® P Tobramycin) was pressurised at the 3 minute mark with insertion of the prosthesis (Zimmer Versys size 11) at the 5 minute mark. No intraoperative complications were noted. Post operative radiographs revealed a worrisome collection of cement that appeared discontinuous with the femur shaft. A

periprosthetic cortical breach was suspected and the patient was initially placed on non-weight bearing status. A CT scan was subsequently ordered which revealed an intact femur shaft cortex. Cement was seen propagating retrogradely through a nutrient vessel with the neck of this propagation clearly demarcated on the axial and coronal cuts (Fig. 3).

DISCUSSION

The nutrient artery of the femur originates from the second perforating branch of the deep femoral artery (4). A second nutrient artery may exist and

this branches from the first or third perforator. In a cadaveric study, Yamamoto *et al* found a single nutrient artery in 55% (11 of 20) of cases and two nutrient arteries in 45% (9 of 20) (10). The nutrient artery enters the femur posteriorly along the linea aspera and transverses the cortex obliquely upwards towards the femoral head. It gives off ascending and descending branches in the medullary cavity that run parallel to the femoral long axis. These branches divide further into smaller walled arterioles, forming capillary networks by anastomosing with the venous sinus plexus which supplies the haversian canals. From these venous sinuses, blood drains to a central longitudinal vein and then back via the nutrient veins. Thus, there is a circular pattern to blood flow within the marrow cavity, from the center of the marrow cavity toward the periphery of the marrow cavity then back toward the center.

The location of the nutrient artery canal has been described by Schiessel *et al* (8). In a radiological study of 129 extremity cases, they reported the distance between the tip of the greater trochanter and the proximal end of the nutrient artery canal to be 170 ± 25 mm and the canal length to be 27 ± 9 mm long. In an anatomical study, Farouk *et al* found a constant topographical relation of the nutrient artery to the femoral shaft and the tip of the trochanter (2). The distance between the tip of the trochanter and the nutrient foramen of the femur averaged 161 (205-150) mm in their study. The femur was divided into sixths and the position of the nutrient artery and foramen was found to lie consistently in the third sixth.

Our Asian patients are shorter in stature with a relatively shorter femur compared to the Caucasian population. The distance of the nutrient foramen from the tip of the greater trochanter is expected to be less than the average measured in the above studies. The location of the site of cement extrusion into nutrient foramina corresponds with the 3rd sixth of the femur where the nutrient foramina are located.

Cement retrograde filling of nutrient vessels with or without extravasation post total hip replacement or hemiarthroplasty is a very rare phenomenon sporadically reported in literature. A case of an 80-

year-old woman with severe coxarthrosis who underwent cemented total hip replacement was reported by Nogler *et al* (6). Retrograde cement filling of the nutrient vein was noted on routine post-operative radiographs and confirmed with a CT scan. Panousis *et al* (7) reported a case with extensive retrograde cement filling of the nutrient artery of the femur in a 60-year-old female following total hip arthroplasty for severe osteoarthritis of the hip. Skyrme *et al* (9) also reported a case of intravenous polymethylmethacrylate after cemented hemiarthroplasty of the hip in a 72-year-old female. There were no immediate or late complications noted in the above cases.

This is a rare phenomenon and appears to coincide with the implementation of modern third generation high pressurization cementing methods. We infer that the normal caliber of the nutrient vessels does not allow retrograde cement filling unless under high pressurisation. It is pertinent to report and recognize this phenomenon and discuss its clinical implications with the routine pressurisation of polymethylmethacrylate in today's modern cementing methods. Pressurisation of the cement in the early and more liquid stages may also increase the risks of cement entering the nutrient vessels.

This finding must be differentiated from the worrisome complication of cortical perforation as the risk of fracture propagation at the site of a perforation is increased. Delaying the weight bearing status of a patient after hip replacement due to an erroneous diagnosis of iatrogenic femur cortical breach increases the complications that can arise from prolonged recumbency. We suggest that a CT scan of the femur be done routinely and expediently upon detection of a radio-opaque density on post-operative radiographs. This will allow early diagnosis and exclusion of an iatrogenic cortical perforation of the femur.

We noted no acute or chronic detrimental clinical consequences. At the time of last follow-up for all three patients, the location of cement extrusion and prosthesis alignment remained unchanged. Avascularity of the femur is unlikely secondary to obliteration of the nutrient artery alone due to the other perforating branches of the deep femoral artery which supply overlying the periosteum

segmentally. There is however a theoretical risk of arteriovenous thrombosis and/or cement embolisation to the lungs. These potential risks must be borne in mind after cemented hemiarthroplasty or total joint replacements.

REFERENCES

1. **Askew MJ, Stege JW, Lewis JL et al.** Effect of cement pressure and bone strength on polymethylmethacrylate fixation. *J Orthop Res* 1984 ; 1 : 412-420.
2. **Farouk O, Krettek C, Miclau T, Schandelmaier P, Tscherne H.** The topography of the perforating vessels of the deep femoral artery. *Clin Orthop Relat Res* 1999 ; 368 : 255-259.
3. **Hiesel C, Norman T, Rupp R et al.** In vitro performance of intramedullary cement restrictors in total hip arthroplasty. *J Biomech* 2003 ; 36 : 835-843.
4. **Laing PG.** The blood supply of the femoral shaft. *J Bone Joint Surg* 1953 ; 35-B : 462-466.
5. **Noble PC, Collier MB, Maltry JA et al.** Pressurization and centralization enhance the quality and reproducibility of cement mantles. *Clin Orthop Relat Res* 1998 ; 355 : 77-89.
6. **Nogler M, Fischer M, Freund M et al.** Retrograde injection of a nutrient vein with cement in cemented total hip arthroplasty. *J Arthroplasty* 2002 ; 17 : 505-506.
7. **Panousis K, Young KA, Grigoris P.** Polymethylmethacrylate arteriography – A complication of total hip arthroplasty. *Acta Orthop Belg* 2006 ; 72 : 226-228.
8. **Schiessel A, Zweymüller K.** The nutrient artery canal of the femur : a radiological study in patients with primary total hip replacement. *Skeletal Radiol* 2004 ; 33 : 142-149.
9. **Skyrme AD, Jeer PJS, Berry J, Lewis SG, Compson JP.** Intravenous polymethylmethacrylate after cemented hemiarthroplasty of the hip. *J Arthroplasty* 2001 ; 16 : 521-523.
10. **Yamamoto Y, Ohura T, Sugihara T.** An anatomic study for a vascularized bone flap of femur. *Plast Reconstr Surg* 1995 ; 95 : 520-525.