Challenges in Primary Hip Arthroplasty for Neglected Post-traumatic Hip Dislocations with Acetabular Defect

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Abstract

Primary hip arthroplasty in the presence of acetabular defect seen in patients with neglected post-traumatic hip dislocation is quite challenging due to the need in securing stability of hemispherical cup and providing enough rigid fixation needed to prevent acetabular cup micromotion. In segmental acetabular defect, contained or uncontained, there is an acetabular rim violation, an important risk factor for cup micromotion, loosening in the long term and subsequent failure. In our environment, most of the patients with post-traumatic hip dislocation present late, making conservative management (closed reduction and traction) or primary acetabular restorative reconstruction very difficult, hence the surgeon is left with the option of either Girdlestone excision arthroplasty, arthrodesis, hemiarthroplasty or total hip replacement. For the few who present early, most of them may not afford the cost of surgery (total hip replacement) and majority of centres in developing countries do not have facilities and trained personnel to handle such complex procedures. Impaction of cancellous bone graft to the acetabular defect is a common practice among arthroplasty surgeons. This, however, does not guarantee bony ingrowth at cup/graft interface and initial rigid fixation. The resultant acetabular cup micromotion on commencing weight-bearing would affect biologic fixation and may explain the relatively high incidence of loosening in this category. It is with this background that we review this important topic in hip arthroplasty highlighting various options of treatments, outcomes and recommendations.

Keywords: Acetabular defect, challenges, post-traumatic hip dislocation, primary hip arthroplasty

Introduction

Total hip arthroplasty is now a well-established method of treating various end-stage hip disorders. Primary hip arthroplasty for neglected hip dislocation with acetabular defect is technically demanding to perform. This is due to anatomical distortions that make access to acetabulum and femoral head difficult, coupled with possibility of utilising custom-made implants such as acetabular augments and cages depending on the extent and pattern of the bone defect. Availability and additional cost of these expensive implants, surgeon's training and wherewithal to handle such complex procedures is another important consideration. There is also a challenge of achieving mechanically sound rigid acetabular cup fixation, an important factor for bony ingrowth to non-cemented hydroxyapatite or trabecular metal (TM) surfaces providing biologic fixation. The presence of micromotion will certainly lead to early loosening and subsequent failure. The merits and demerits of non-cemented versus cemented, hybrid and reverse hybrid fixations have also been taken into consideration so as to help in deciding the best choice of fixation with respect to the age of patient and background pathology.

Patient Evaluation

Majority of patients with post-traumatic hip dislocation are usually involved in dashboard injuries and present to the hospital late due to initial patronage of traditional bonesetters. For those who present early, standard protocol of management is commenced immediately, including resuscitation, detailed history taking, complete physical examination, radiological and other supportive investigations. Closed reduction is

Access this article online

Quick Response Code:

Website: www.njotonline.org

DOI: 10.4103/njot.njot_21_20

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How to cite this article: Maitama MI, Lawal YZ, Ejagwulu FS, Kabir AM, Ismaila LD. Challenges in primary hip arthroplasty for neglected post-traumatic hip dislocations with acetabular defect. Niger J Orthop Trauma 2020;19:73-6.

Submission: 13.06.2020 **Revision:** 07.07.2020

Acceptance: 24.08.2020 **Published:** 15.12.2020

attempted and, if successful, maintained by skeletal traction application for 4–6 weeks, followed by gradual mobilisation and physiotherapy.

For patients who come to the hospital late, 3 months or more after injury, they usually present with complaints of hip pain, difficulty in walking, loss of hip abduction and limb shortening on the affected side that is also flexed and adducted, classic for posterior hip dislocation or abducted and externally rotated in the rare anterior type. Standard plain radiographs and three-dimensional computed tomography reconstruction, where available, confirm the clinical diagnosis of post-traumatic hip dislocation that may be associated with acetabular fracture. The extent of injury in terms of greater trochanteric superior migration, associated femoral head fracture, pattern and extent of acetabular bone loss and preservation of medial plate bone are carefully evaluated. Such patients are offered primary total hip arthroplasty, but a number of them will consent to have Girdlestone excision arthroplasty as a salvage due to issues with affordability. For the few who could afford the procedure, they are further evaluated, optimised for surgery and informed consent obtained, highlighting the possibility of sciatic nerve damage, infection, haemorrhage, limb length inequality, component dislocation and loosening.

Challenges in Surgical Technique

Difficulties encountered are due to superior migration of femoral head with adhesions to the pelvic wall and soft-tissue contractures making it difficult to bring it down to its normal anatomy during reduction after component placement. This is usually encountered in patients with long-standing dislocation who spent years bearing weight on the pathologic hip. Some authors will undertake the surgery as a staged procedure by initial open exploration, soft-tissue release, followed by total hip arthroplasty after 3–6 weeks of skeletal traction.[1] Others will offer subtrochanteric shortening step-cut osteotomy and effect reduction at primary sitting.[2] In the course of soft-tissue release muscle, attachments to greater trochanter may be avulsed risking damage to abductor mechanism. Due to fibrosis, anatomical distortion and myositis ossificans sciatic nerve may be damaged during exploration and femoral head resection. Equally challenging is acetabular identification that is usually filled with osseofibrous tissues, and in the course of defining it, there may be extensive soft-tissue dissection and bleeding. Due to non-weight transmission in long-standing cases, the acetabulum is usually osteoporotic, an important consideration during reaming so as not to overream to perforation. The presence of posterior defect in the acetabulum may lead to erroneous decrease in anteversion by inexperienced surgeons during acetabular reaming and cup placement all in an attempt to achieve more containment, as the more the anteversion position, the more the cup is likely to be exposed by the defect posteriorly. This may lead to incorrect cup placement (decreased anteversion, neutral or retroversion) risking post-operative dislocation. Some surgeons in order to overcome this will prefer using small acetabular cup in high hip centre position so as to have more containment, but this is not advised as it may be associated with post-operative limb length inequality and subsequent early failure. Some patients may present with shallow dysplastic acetabulum seen in neglected adolescent traumatic dislocations due to acetabular mal development. In such cases, placing the hemispherical cup in the dysplastic acetabulum may likely be lateral to the true anatomic hip center of rotation, therefore attempt should be made to medialize it for its correct positioning. where available, complement of image intensifier may assist surgeon to achieve best balance between under reaming with incorrect cup positioning on one hand, and over reaming to medial wall perforation and/ or medial plate bone fracture during cup impaction on the other hand.

Discussion

The principles governing the management of primary total hip arthroplasty in the presence of acetabular defect, segmental or cavitary and revision hip arthroplasty are essentially the same due to the likely presence of a common denominator that is acetabular bone loss. Primary total hip arthroplasty in the presence of acetabular bone defect is truly challenging to the arthroplasty surgeon due to the need for providing initial rigid mechanical stabilization that should withstand the routine biomechanical loading of components in all the axes within the physiologic ranges of hip motion. This is usually achievable in primary setting either by filling the defect using bone graft, bone cement, porous metal wedges as acetabular augments with regular or customised acetabular cups, acetabular cages and reinforcement rings.

For cavitary defect, as seen in neglected central hip dislocation with both column's acetabular fracture and secondary congruence, packing the defect with morselized and/or structural autograft is usually adequate in restoring the medialized hip centre of rotation and preventing cup migration into the pelvis by the process of revascularisation, incorporation and subsequent ossification to form the medial plate bone. Sometimes, anti-protrusio cages, cup-cage constructs or reinforcement rings are used to protect these grafts before the healing process is completed.[3,4] Slooff *et al*.[5] have used both bone cement and bone graft in revision setting for cavitary bone loss with good result. The main drawbacks of acetabular cages are: they are usually designed with non-biologic surfaces because they are meant to be flexible to accommodate different pelvic shapes, so being just a mechanically supportive metal, it may be subjected to long-term fatigue failure. Being bulky, extensive dissection, risking soft-tissue devascularisation, may occasionally have to be undertaken for its proper placement.

In segmental bone loss, however, the rationale of using bone graft to fill the acetabular defect, which is common practice, needs to be critically looked at. This is due to the fact that uncemented porous-coated acetabular cups are not expected to gain bone ingrowth and subsequent long-term stability from areas in which they are exclusively in contact with bone grafts (two dead surfaces cannot anchor a living process). Rather, in these areas, a fibrous membrane between the graft and uncemented implant usually forms[6] which will not be expected to provide long-term implant fixation reliably. van Haaren *et al*. have already reported a high failure rate of impaction grafting in large acetabular defects.[7] These grafts are sometimes at risk for fracture or collapse from fatigue failure, just like any other dead bone or occasionally may be resorbed putting the implant at risk of loosening and/or migration. Zahar *et al*.[8] have reported a high loosening rate in primary total hip arthroplasty, even though among patients with developmental dysplasia of the hip, using bulk autograft at mid-term follow-up. Shinar and Harris[9] have reported an acetabular failure rate of 60% at 12.5 years for the primary total hip arthroplasties reconstructed with bulk autograft and went on to conclude that the main parameter associated with failure was the extent of cup-to-graft coverage. When more than 30% of the superior aspect of the cup was supported by graft, there was a significantly higher risk of failure. Long-term results have shown unacceptably high loosening rates of the acetabular component with structural autografting or allografting.[10-14] Despite its widespread use and the favourable outcome reported by some authors, much is still not known about the biological fate of these bone grafts due to scanty data of long-term autopsy retrievals.

Before the advent of the concept of biologic fixation of cementless acetabular and femoral components by process of bony ingrowth on to hydroxyapatite or TM acetabular cups, acrylic bone cement was generally used with or without additional bone graft to provide skeletal fixation. However, due to moderate-to-high failure rate at long-term outcome,[15-20] acrylic bone cement is not usually the surgeon's first choice in providing skeletal fixation, particularly in younger active population except in selected difficult primaries and revision procedures. Even then, some surgeons still report a longer survival rate of non-cemented than cemented cups in revision setting.[21,22] Despite the improved cementing technique, it only showed to decrease the rate of cemented femoral stem loosening not the cemented acetabular component which remains unchanged.[23] It is generally agreed that biologic fixation tends to give better to excellent long-term outcome in primary arthroplasty than cemented procedure,[24] particularly in young active population.[25] Biologic fixation, however, depends on several variables for it to be effective. These include quality of host bone (i.e., osteoporosis), age and general health of the patient, effective clearance of acetabular cartilage, adequate impaction (press-fit) and close contact of metallic cup with the host bone cavity, containment of the hemispherical cup and percentage coverage by the acetabular anatomy, initial rigid mechanical cup stability, presence or absence of micromotion, presence or absence of bioactive coatings i.e., plasma spray, onto the porous cup surfaces and quality standards of these implants by manufacturing companies. Not surprising, therefore, that uncemented hip arthroplasty may be associated with high failure rate due to loosening in elderly population as reported by some authors.[25,26] Longer survivorship of cemented over non-cemented fixation in elderly patients 65 years and above was reported by Mäkelä *et al*.[27] using both Kaplan–Meier and multivariate Cox regression analyses adjusted for age, sex and diagnosis at various age groups using revision for any reason as end point.

Oblong- or bilobed-shaped cups are non-hemispherical components that have been available from several manufacturers designed mostly to deal with large segmental defects. However, these implants are expensive and difficult to use by most surgeons because of their complex geometry.

The presence of micromotion has been shown to significantly affect the rate of bony ingrowth[28,29] and subsequent biologic fixation unto hydroxyapatite or TM porous surfaces.[30] Using finite element analysis, it has been demonstrated that fixing one dome screw does not offer the stability of a hemispherical prosthetic cup that was not press fitted and two dome screws do not prevent micromotion at the pubis or ischium significantly.[31] This is more pronounced in the presence of posterior superior acetabular rim defect even if contained. Some authors, in assessing the demographic and disease-specific factors at primary surgery that may have influenced acetabular and femoral component survival, have found a relative risk of loosening in congenital[32] and traumatic causes,[33] which may well have been the failure to achieve initial rigid mechanical stabilisation in the presence of bone defect, among other factors. For this reason, some surgeons will use porous metal wedges, like modular tantalum acetabular augments, which have the properties of increased porosity, high coefficient of friction and greater bone in-growth potential, to first address the defect and provide structural support and containment for the hemispherical acetabular cup[34,35] with satisfactory outcome of early and mid-term results.

Conclusion

Different methods and opinion will continue to exist concerning the best way to manage acetabular bone loss associated with neglected post-traumatic hip dislocation at primary surgery among the available options of autogenous bone grafting, all cemented or reversed hybrid fixations, multiple screws fixation using multihole cementless acetabular cup, the choice of leaving "small defects alone" or reconstruction with acetabular augments for larger defects at primary surgery. Whatever method so chosen, restoring hip centre of rotation, correct cup placement and achieving sound mechanical stability will strongly be desirable in maximising potential for satisfactory long-term outcome.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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