The General Surgeon

ISSN 2687-7007

Review Article

Periprosthetic Fractures of Total Hip Arthroplasty: A Review of Literature with a Point of View

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Abstract

Periprosthetic fractures associated with total hip arthroplasty are becoming increasingly more common. The purpose of study is to review the treatment of periprosthetic fractures of total hip arthroplasty. A limitated number of cases is proposed. Careful intraoperative technique and tissue handling are crucial to reduce periprosthetic fractures. Once identified, however, any number of well described the treatment options are available for the surgeons. Carefully approached, and using sound treatment principles, these fractures can be appropriately addressed, thus ensuring adequate patient results. In this review, there are not outcomes.

Keywords: Periprosthetic fractures; Total hip arthroplasty; Intraoperative technique; Pain

Introduction

In our experience, we are seeing a higher incidence of arthritis in younger patients. Total hip arthroplasty has become an increasingly popular and highly effective method of treating both pain and disability associated with this condition. Unfortunately, an otherwise excellent result from hip replacement can be compromised by any number of complications, not the least of which is a periprosthetic fracture. A review of the literature suggests that the prevalence of periprosthetic fractures associated with total hip replacement is increasing [1]. They can occur both intraoperatively and postoperatively, and involve either the acetabulum or femur.

Intraoperative Acetabular Fractures

Perhaps due to a low incidence of periprosthetic acetabular fractures, a limited number of the studies regarding this phenomenon are available in the literature [2-9].

McElfresh and Coventry [9] documented an almost imperceptible incidence of 1 periprosthetic acetabular fracture among 5,400 cemented total hip replacements, or 0.02%. Similarly, Peterson and Lewallen [7] described a total incidence of 16 periprosthetic acetabular fractures among 23,580 hip replacements, or 0.07%. Factors postulated to be associated with intraoperative acetabular fractures include the use of uncemented components [8], under reaming [10], osteopenia [8] and Paget's disease [4]. Despite suggestions that the incidence of periprosthetic acetabular fractures has been increasing, and is primarily due the advent of uncemented acetabular component implantation, the literature fails the conclusively support this sentiment [7,11]. With the exception of only a handful of case reports and case series [2-9], little information is available on the subject. It is likely that this event goes highly unreported.

No clinically relevant classification of intraoperative periacetabular fractures has been described in literature. The use of Letournel [12], classification system would be reasonable due to its utilization of anatomic location of the fracture. Treatment options would depend fracture location and severity as well as implant stability [13]. If the fracture is minor and the implant is stable then it is reasonable due to simply augment the component with additional screw fixation if possible, though it is arguable that these fractures could perhaps be left untreated. If the fracture is more severe and the cup is unstable, then fracture fixation with a plate or screw or use of a shelf-graft-like augment of the deficient area coupled with reapplication of another cemented cup would be warranted.

Postoperative Acetabular Fractures

Although postoperative periacetabular fractures are described to occur infrequently [13], one report reports 0.9% prevalence identified at the time of revision surgery [14]. As the reported prevalence of periacetabular fractures appears to be higher postoperatively than intraoperatively [8,9], it is quite possible than this trend represents a failure of identification of the fracture at the time of surgery. It more likely, however, that postoperative periacetabular fractures occur in due process as a result of bone loss and osteolysis and revision surgery is therefore indicated.

Only one classification system of postoperative periacetabular fractures has been identified in the literature [7], stratifying fractures into two groups: Type 1 with the component found to be both clinically and radiographically stable; and Type 2 with an unstable component. Despite having relevance with respect to treatment options, this study had a limitated number of cases.

Nonetheless, it is imperative that these fractures are identified prior to attempting revision surgery in order to ensure availability of any necessary implants or fixation devices including, among others, jumbo cups, antiprotusio cages and bulk/structural allograft.

Intraoperative Femoral Fractures

Of all varieties of periprosthetic fracture, clearly more has been written about fractures of the femur. Undoubtedly, this is in direct

Citation: Bernardino S. Periprosthetic Fractures of Total Hip Arthroplasty: A Review of Literature with a Point of View. Gen Surg. 2019; 1(3): 1013.

Publisher Name: Medtext Publications LLC

Manuscript compiled: Nov 29th, 2019

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relation to its reported higher incidence as compared to other fracture types. In particular, the incidence of intraoperative fractures appears to be related primarily to the type of component used and stage of surgery. In this regard, periprosthetic femur fractures occur much more commonly with uncementeded femoral components. In a complex review of the Mayo Clinic Joint Registry, Berry [15] describes a periprosthetic femur fracture rate of 5.4% with uncemented femoral components as compared to 0.3% for cementeted components in primary hip replacements. These numbers strongly support the notion that the incidence of periprosthetic fractures has been increasing in recent years given the preponderance of the surgeons now preferentially choosing to implant uncemented components.

Other associated risk factors include female gender [16], patients with metabolic bone disease, Paget's disease, osteopetrosis, rheumatoid arthritis [17], osteoporosis [18], cortical perforation of the femur [9], previous hip surgery and a small femur.

Furthermore, Berry [15] also described a higher rate of intraoperative femur fractures in revision (7.8%) as compared to primary (1%) joint replacement. One can only assume that the higher incidence seen with uncemented components is attributable to difficulties involved with ensuring a secure press-fit by using undersized broaches and reamers, something unnecessary with cemented components.

Classification

A number of classification systems have been developed to describe periprosthetic fractures of the femur [16,18-24], though the Vancouver Classification by Duncan and Masri [19] is not the most widely accepted, as it bears relevance to treatment.

However, this classification was intended to specifically address postoperative periprosthetic femoral fractures. As a result, Masri et al. [11] have recently modified the original classification to appropriately consider intraoperative fractures of the femur.

Whereas the original classification stratified fractures based not only on location, but also on the status of the femoral component as well as the quality of bone present [19], the modified version also includes the location, pattern and stability of the fractures [11].

Modified Vancouver Classification and Treatment Options

In this modification of the original classification system, developed to address fractures identified intraoperatively, fractures are similarly divided into location with Type A representing proximal methaphyseal fractures not extending into the diaphysis, Type B involving the diaphysis but not distal diaphysis and Type C fractures are distal diaphyseal that can extend into distal femoral methaphysis. These types are then further subdivided into Subtype 1, which represents a simple cortical perforation; Subtype 2 representing un displaced longitudinal fractures and Subtype 3 representing displaced and unstable fracture patterns.

Postoperative Periprosthetic Femur Fractures

As mentioned above, the Vancouver classification was originally designed to address periprosthetic fractures of the femur identified postoperatively. This system stratifies fractures based on location, stability of the implant and quality of the bone stock.

Vancouver classification and treatment options

Type A: These fractures involve either the greater trochanter (Ag) or the lesser trochanter (Al) and are usually associated with osteopenia. Intraoperative longitudinal cracks of the proximal femur, including specifically the calcar, can be considered to be Type A fractures. These fractures can be treated either by cerclage wiring (for Al) and claw fixation (for Ag) in conjunction with protected weight-bearing postoperatively.

Type B: Type B fractures are those that occur around the step or stem tip but not distal to it.

They are stratified as fellows: B1 has well-fixed stem; B2 has a loose stem; and B3 has a loose stem with poor proximal femoral bone quality.

B1 fractures that are either long oblique or spiral fractures can be treated with cerclage wires and crimp sleeves, though it is also arguable to utilise plate fixation in this category. Short oblique or transverse fractures must be treated with either plate fixation, cortical onlay struts or both (Figure 1) [25]. A number of different devices are available for fixation of these fractures including the AO/ASIF plate, the Mennen plate, the Ogden plate, Dall-Miles plate, Cable Ready plate and less invasive stabilization systems (LISS) plate. B2 fractures demand a revision of the femoral component to a longer perhaps fully coated stem to gain diaphyseal fixation. These can be used in conjunction with only structs or plates to help both with initial stabilization of the fracture and to improve bone stock (Figures 2A and 2B).

B3 fractures are the least common though greatest challenge to deal with. In these fractures, careful preoperative planning is an absolute necessity. Either a tumour-type or megaprosthesis or a Proximal Femoral Allograft (PFA) and prosthesis composite are the only true viable options. In the latter, a long smooth stem is cemented into a PFA which is appropriately sized to fit into the deficient proximal femur. The PFA is fashioned to join to the native diaphysis with either an oblique or step cut to help control rotation and increase the surface area in which to heal. The native diaphysis is prepared to accept the long stem with a tight interference fit. The main goal of this composite is to have a completely stable proximal construct, while allowing the PFA and host bone junction to heal with the assistance of either only structs or morselised graft. It is not intended for the distal end of the stem to have a porous coating as this would allow for in growth of the native diaphysis on the stem of the composite and hence prevent the junction from healing. The remnant of the native

Figure 1: Type B1 fracture with stable cemented implant and good bone stock having a long spiral pattern repaired using cerclage wires.

proximal femur, with its soft tissue attachments, is often treated with an extended trochanteric osteotomy and is wrapped around the new composite to act as living bone graft.

Type C: These fractures occur well distal to the implant and can also extend into the distal femoral metaphysic. Type C fractures should be treated independently of the femoral stem, as by definition the stability of the femoral component stem, as by definition the stability of the femoral component has not been jeopardized. A number of fixation devices are available to address these fractures including, among others, fixed -angle or locking plates, retrograde intramidullary nails and cortical onlay strut allografts with cerclage wires (Figure 3).

Figure 2A: Type B2 fracture with loose uncemented prosthesis addressed via. revision of the femoral stem and cortical onlay struct allograft and cerclage wires. Cup revision was also performed. Fracture in this case was likely due to osteolysis.

Figure 2B: Type B2 fracture with loose cemented stem converted to long uncemented revision stem and adjunct cable plate and screws.

Figure 3: Type C, fracture, though also above a total knee replacement, with a stable cemented femoral stem treated with a fixed angled device.

Conclusion

Periprosthetic fractures associated with total hip arthroplasty are becoming increasingly more common and are ambitious tasks to deal with, even for the most experienced surgeons. Careful intraoperative technique and tissue handling are crucial to reduce their incidence. Once identified, however, any number of well described treatment options are available for the surgeon.

Carefully approached, and using sound treatment principles, these fractures can be appropriately addressed, thus ensuring adequate patient outcomes.

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