Coupling Device and Distal Femoral Replacement for Periprosthetic Supracondylar Femur Fractures with an Ipsilateral Total Knee and Hip Replacement

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Abstract *Background:* Periprosthetic supracondylar fractures in the setting of an ipsilateral total knee and hip replacement are a rare but serious orthopedic challenge. *Description of Technique:* In this unique situation, we consider insertion of a custom coupling device with a distal femoral replacement as an appropriate surgical solution that allows for stability and preserves hip and knee functionality, while not relying on the poor healing potential of the remaining intercalary femoral bone. *Patients and Methods:* We report the outcomes of two patients who underwent this custom coupling procedure. *Results:* These custom devices resulted in successful outcomes with restoration of ambulatory function and range of motion at greater than 14 months follow-up. *Conclusions:* We found that this technique provides sufficient stability and preserves functionality in a difficult-to-treat patient population. The results indicate that this technique may be considered as an alternative to more invasive procedures including total femoral replacement and complete femoral allograft constructs.

Keywords periprosthetic fracture · coupling device · femoral replacement · total knee replacement · total hip replacement

Introduction

The presence of a supracondylar or distal femoral fracture in a patient with an ipsilateral total knee arthroplasty (TKA) is an orthopedic challenge. The situation has been addressed successfully with a number of methods in the past, including distal femoral replacement [4, 8], less invasive stabilization system plate [5], retrograde intramedullary nail [3, 12], and blade plate [2]. In the presence of an ipsilateral total hip arthroplasty (THA), this challenge can become increasingly difficult, since the intercalary bone is short, often of extremely poor quality, and has compromised healing potential. A number of case studies report operative methods for treatment of this unique patient group, although each technique has had its own limitations [1, 7, 11, 14]. Total metallic femoral replacements have been reported a number of times in the literature, but often result in limitations in functionality [1, 11]. Femoral allografts have also been used, although this technique has inherent weaknesses associated with non-union and late allograft resorption [14].

Previously, we have reported on a single case of a custom coupling device linking a primary total knee and a long-stem total hip stem in the setting of a femoral non-union in a patient with severe osteoarthritis of the knee [10]. We now report the results of an additional two patients using a similar approach, but in which the distal femur was not preserved. In addition, while the first reported patient linked an existing total hip to a primary total knee replacement, the patients in this series underwent treatment of a distal femoral fracture in the setting of an existing ipsilateral total hip replacement with an existing ipsilateral total knee arthroplasty. These cases may seem unique, but they are becoming more frequent with

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the increased prevalence of patients with ipsilateral total hip and knee replacements. While periprosthetic supracondylar femur fractures in elderly osteoporotic patients with an existing knee replacement are often treated with a distal femoral replacement [4, 8], this simple option is not available to patients with an existing total hip replacement.

In these unique situations, we consider that the use of a custom coupling device with a distal femoral replacement is an appropriate surgical solution that allows for stability and preserves hip and knee functionality, while not relying on the poor healing potential of the remaining intercalary femoral bone.

Description of Technique

Surgical placement of the coupling device is dependent on appropriate design. A suitable design requires addressing a few critical issues. First, we determined the size and design of the existing hip replacement. We decided the size of the existing implants by checking the operative notes to determine the previously implanted device. When necessary, the manufacturer was contacted to get specific dimensions. Finally, these dimensions were verified using calibrated radiographs. We calibrated based on the size of the femoral head of the total hip replacement to assure correct magnification. A CT scan was used for one of the two cases. They are not necessary, but do help to visualize the fit of the implant within the bone. Artifact from metal hardware precludes us from using CT to accurately determine the size of the implants.

An accurate size is required in order to design a recipient end or docking site that can accommodate the size of stem. We looked for a minimum cement mantle of approximately 0.5 mm. Once the inside diameter of the tube was determined, we then established the overall width of the coupler. A 2-ml wall diameter is sufficient. We then determined if the tube fits inside the periosteal border of the bone. We believed 2–3 bone diameters of fixation length between the tube and the distal femoral component is appropriate to provide fixation between the implant and the coupler. A vent hole was placed for one of the two couplers to reduce a potential vacuum phenomenon. However, we do not think this is essential because the length of the tube is relatively short and cement can extrude out from the top, reducing a significant vacuum effect. In addition, in order to provide rotational stability between the inside of the coupler and the cement mantle, anti-rotation grooves were cut into the inside of the coupler. These grooves were machined into the tube by the manufacturer. It is worth noting that no patient-specific instrumentation was required for these cases. Off-the-shelf disposable trephines that matched the diameter of the coupler were ordered to help prepare the bone. Overall, the time from order of the custom implant to surgery date was about 3 months.

In a previously reported case, preservation of the distal femur was attained based on the determination of adequate bone-healing potential and utilization of an intramedullary coupler [10]. In the current study, based on clinical history

and available radiographs, suspicion of poor bone stock was confirmed intraoperatively for both patients, and, therefore, placement of a distal femoral replacement was judged to be more appropriate. For insertion of the coupling device with distal femoral replacement, we followed similar steps for both patients, with patient-specific details outlined in [Methods](#). Both patients required removal of the previous total knee replacement components and the remaining distal femur. Therefore, the bone, which included the periprosthetic fracture, was removed, in addition to any previous fracture hardware. After appropriate bony preparation of the distal femur, the custom-made sleeve was placed over the distal aspect of the hip stem, and a distal femoral replacement was then used as the revision total knee replacement.

Patients and Methods

Patient charts of the senior author were retrospectively reviewed to obtain the records of the two patients who underwent this coupling procedure in the setting of a supracondylar fracture. The preoperative, intraoperative, and postoperative patient records were thoroughly reviewed, and relevant information regarding clinical exams, radiographic analysis, operative technique, and implant design was reported in this study. Prior to surgery, both patients were non-ambulatory. In these patients, the custom device described was coupled to a revised total knee replacement. Neither of the patients in our study required emergency surgical intervention and therefore, conservative management with non-ambulatory activity was recommended until the design was ready.

Patient One

A 74-year-old female with severe rheumatoid arthritis underwent bilateral primary total knee replacements in 2004 for osteoarthritis, followed by a left total hip replacement in 2007. She presented to our facility in late 2009 after having a supracondylar femoral fracture on the left side that required open reduction internal fixation, but went on to non-union, with continued pain and discomfort. Radiographs showed a broken lateral side plate with locking screws from the previous attempt to achieve fracture union (Fig. 1a). Due to debilitating pain, the patient was essentially non-ambulatory. In early 2010, the patient finally agreed to proceed with surgical intervention. Through the previous anterior knee approach, the total knee replacement components and the remaining distal femur were removed along with all fracture hardware. The remaining intact distal femur was exposed and trephines were used to provide space for the distal coupling device. Following appropriate bony preparation, the custom-made sleeve (Stryker, Kalamazoo, MI) was placed over the distal aspect of the hip stem. A distal femoral replacement with a rotating hinge prosthesis was then used as the revision total knee replacement (Stryker, Kalamazoo, MI), with coupling of the sleeve achieved through cement fixation (Fig. 1b).

Fig. 1. Radiographs of patient one. **a.** Preoperative radiograph showing the broken lateral side plate with locking screws. **b.** Postoperative radiograph showing the coupling device and distal femoral replacement.

Patient Two

A 71-year-old female had a history of multiple hip procedures dating back from a car accident in 1949. She underwent a left total hip replacement in 1984, and a right total hip replacement in 1970, with subsequent revision of the right in 1999 for a stem fracture. She also had history of a right total knee arthroplasty in the distant past with a revision in 1995. In February 2010, the patient underwent re-revision of the right hip for pain and multiple dislocations, with exchange of the femoral head, acetabular cup, and insertion of a constrained liner. The patient did well until June 2010 when she suffered a periprosthetic supracondylar fracture following a fall. The fracture crossed the cement mantle at the tip of the stem of the knee component. The patient underwent initial open reduction and internal fixation (ORIF) surgery utilizing a femoral strut graft and six cables. Minimal bone of the femoral condyle precluded the use of a long plating system, because there was little bone for distal screw fixation. The ORIF failed

and the graft cracked 2 months later (Fig. 2a). Due to failure of the construct and her poor bone quality, the total knee replacement was revised to a distal femoral replacement with a rotating hinge prosthesis custom mated to her proximal femur stem (Biomet, Warsaw, IN), following similar methods as described for patient one (Fig. 2b).

Results

There were no major or minor intraoperative complications for either patient. Postoperatively, Patient one was allowed full weight bearing and now ambulates independently with a

Fig. 2. Radiographs of patient two **a.** Preoperative radiograph showing periprosthetic fracture above a total knee arthroplasty with significant femoral deformity **b.** Postoperative radiograph showing the coupling device and distal femoral replacement.

cane. Her postoperative passive and active range of motion is 0–100° at 22-months follow-up.

Patient two was allowed full weight bearing and has returned to ambulating with a cane. Her post-operative course was complicated by an abscess in the pretibial region that required irrigation and debridement surgery, exchange of the polyethylene components of the rotating hinge total knee, and placement on long-term antibiotic suppressive therapy. She has subsequently returned to full function with a passive and active range of motion of 0–90° at 14-months follow-up.

Discussion

Supracondylar fractures in the presence of a total hip and a total knee arthroplasty are most commonly seen in the setting of osteoporosis or rheumatoid arthritis. These fractures present a unique challenge to the orthopedic surgeon, and the rise in the number of these cases is likely with the rapidly increasing number of hip and knee arthroplasties performed in the USA [6]. Distal femoral replacements are appropriate in the setting of a simultaneous supracondylar fracture and total knee replacement in patients with poor bone-healing potential [8], but are not an option when there is an existing total hip replacement. Therefore, surgical techniques used to address this issue include total femoral replacements and femoral composite allografts, although each has its own limitations [1, 11, 14]. In the appropriate setting, the authors believe that a safe and viable option for surgical treatment is mating of the distal femoral component of a total knee to a total hip stem with sparing of the proximal femur. In this study, we examined the success rate of such a procedure in two patients. We found that this technique provides sufficient stability and preserves functionality in a difficult-to-treat patient population.

Our results suggest that this technique provides a less invasive surgical option for these fractures, without relying on the fracture itself to heal. Urch and Moskal [14] reported the use of an entire femoral allograft with component revision. The most common concerns related to large allograft treatment methods are fractures, non-union, and rapid dissolution of the allograft requiring removal [14]. The stability of our custom implants reduces the risk of non-union and future fracture, and all of our patients, including the one from the previous case study [10], have not had complications related to these issues at greater than 14-months follow-up. Another option, especially in the setting of a failed allograft construct, includes the use of complete metallic femoral replacement [1]. This is a major procedure, with considerable complication risks, and it requires the replacement of the original THA. In addition, they can often result in limited functionality [9].

We are not the first to make use of a device connecting proximal and distal femoral stems. Lachiewicz [7] utilized a custom interpositional femoral device in the presence of a long-stemmed hip and constrained knee. Their system prevented fracture or loosening at 5-years follow-up, although range of motion was markedly limited, with only 30° of flexion at the knee. Tillman et al [13], examined a series of four patients who underwent coupling of the distal and proximal femoral components using a custom-made sleeve that cemented to the hip

stem. These sleeves were significantly longer than the ones used in our study, and only two of the patients had an existing ipsilateral total knee replacement at the time of fracture. At 24-months or greater follow-up, the series had no complications related to mechanical failures, loosening, or new infection, and no further surgery was required for any reason. Range of motion data was not mentioned.

The use of a coupled distal femoral replacement separated these patients from our previously reported case in which the distal femur was spared using a distal intramedullary coupling device [10]. The advantage of the distal femoral replacement is to bypass the need for healing of the fracture itself. This strategy may have an advantage in patients with more severe bone-healing deficits.

Indeed, our custom devices resulted in successful outcomes for our patients. In both patients in this series, stability and functional preservation were achieved. With any knee–hip coupling device, there is concern with excessive stress on the proximal femoral component [13]. None of our patients had issues with mechanical failure, or loosening of either the THA or TKA. The one major complication seen in our second patient was related to infection, which was successfully treated but required irrigation and debridement surgery.

The rarity of a distal femoral fracture in the setting of simultaneous TKA and THA in patients with poor bone quality limits the number of patients we report. Overall, however, this technique resulted in good outcomes in this unique patient population, and should be considered as an alternative to more invasive procedures, including total femoral replacement and complete femoral allograft constructs.

Disclosures

Conflict of Interest: Mathias Bostrom, MD is a paid consultant for Smith and Nephew (outside the work). Matthew Grosso, BS, has declared that he has no conflict of interest. Joseph Lipman, MD is a paid consultant for Smith and Nephew, receives royalties from Ortho Development and Mathys and research support from Stryker (outside the work).

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Informed Consent: Informed consent was obtained from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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