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Case report with the literature review

MULTI-FRAGMENTARY FRACTURE OF THE TIBIAL COMPONENT: A CASE REPORT OF A RARE COMPLICATION AFTER TOTAL KNEE ARTHROPLASTY

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SUMMARY – Total knee arthroplasty is a surgical procedure which is usually indicated in cases of severe osteoarthritis associated with knee pain, which is unmanageable using nonsurgical methods. Although total knee arthroplasty is a well-established treatment modality, it still has several complications which can lead to catastrophic result; implant fracture is one of them. In this case report, we described the case of a 74-year old female who presented with a rare complication of total knee arthroplasty — tibial component fracture. We also presented potential causes and treatment options for such complicated cases.

Keywords: *total knee arthroplasty; complication; implant fracture*

Introduction

An advanced stage of knee osteoarthritis is characterized by persistent pain and reduced range of motion that are unmanageable using nonsurgical methods, causing chronic disability and decreased quality of life[1,2]. In such cases, surgical management in terms of total knee arthroplasty (TKA) is usually indicated. Due to increasing obesity rates and an aging population in the last two to three decades, the number of TKAs performed is expected to rise[3]. Since the early days of TKA, prosthetic design and the surgical procedure have greatly decreased revision rates[4]. While TKA has proven to be a cost-effective way of managing osteoarthritis[5], the number of performed operations has also lead to more revisions being performed[3-5]. The most common causes of revision TKA are infection, instability, aseptic loosening and lower limb malalignment[6-8].

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These complications may vary in occurrence with regards to demographics. Besides the most common complications, rarer complications also exist. These rare complications of TKA lead to catastrophic results in the form of an implant fracture. In a study performed in 2014 by Gilg et al.[8], the authors analyzed twelve clinical studies and datasets from worldwide registers trying to evaluate the incidence of implant fracture in both total and unicompartmental knee arthroplasty. Their review states that implant fracture rates of knee arthroplasties were reported to be 0.2 to 2.5% in clinical studies. In total, 25,961 TKAs were performed and only 22 of those failed due to tibial component fracture. In the worldwide arthroplasty registers, the observed fracture rates amounted to 0.02-0.17%, however, only the Australian registry provided data about the mechanisms of failure. Out of the 393,608 performed arthroplasties, only 301 failures were due to tibial component fracture[8]. Thus, this complication of TKA has a very rare occurrence. Some of these fractures presented as early complications within two years after total knee arthroplasty and some of them presented as late complications. In this paper, we report the case of a 74-year old female who presented with a late and rare complication of TKA — tibial baseplate fracture — twenty-eight years after she underwent primary TKA.

Case report

The patient was a 74-year old female who presented with strong pain and a valgus deformity in the left knee. Due to osteoarthritis of the left knee, she underwent TKA in 1987 and a non-cemented knee prosthesis (PCA, Howmedica) was implanted. According to the patient's statement, the surgical procedure went well, but despite intensive physical therapy, about three months after the procedure she still had a decreased range of motion. She was hospitalized again, placed under short-term general anesthesia and a manipulation with the operated knee was performed. After this procedure, the patient was subjectively satisfied with the operated knee and, as she didn't have any problems, she stopped attending follow-ups. Problems with the operated knee occurred again in 2011. The patient denied previous trauma. In the beginning, she felt a mild pain in the operated knee after everyday activities, such as longer standing or walking, but, due to progressing pain, she reported for a check-up. Because of severe and constant pain, the range of motion in the left knee was minimal and she couldn't walk without crutches. A clinical exam revealed a valgus deformity of the left knee. Palpation

Figure 1. Knee standing radiographs in AP projection

Figure 2. CT scan of the left knee

was very painful and the range of motion was 10-30 degrees in flexion. Radiographs of both knees were performed in the standard anteroposterior (AP) and lateral views. The radiographs revealed tibial component breakage (Figure 1).

Computerized tomography (CT) of her left knee was also performed. The CT confirmed implant fracture together with tibial plateau depression and revealed a large zone of osteolytic reaction under the fractured part of the prosthesis, which impacted in the collapsed bone (Figure 2).

The erythrocyte sedimentation rate, C-reactive protein and white cell count were normal. In accordance with the clinical and radiological findings, a revision surgery was indicated. Intraoperative findings were similar to radiological findings. During the surgical procedure, we found the polyethylene insert broken and the tibial component fractured in the lateral compartment of the knee (Figure 3).

We also discovered a large zone of osteolytic reaction under the fractured part of the prosthesis, which impacted in the collapsed bone. The osteolytic zone extended to the meta-epiphyseal border (Figure 4).

Tissue samples and joint swabs were taken and sent for histopathological and microbiological analysis. According to intraoperative findings, we decided to perform a two-stage revision; we performed surgical

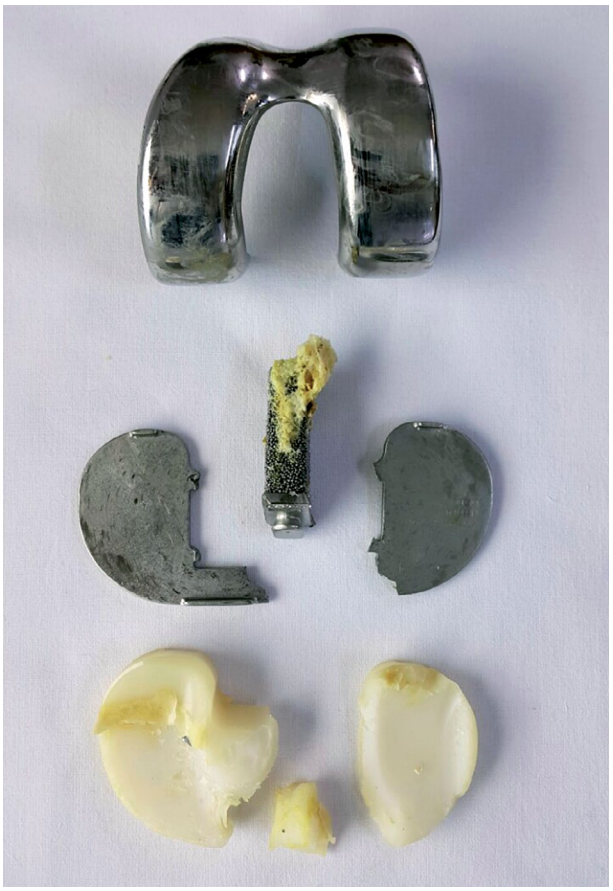

Figure 3. Fractured tibial implant

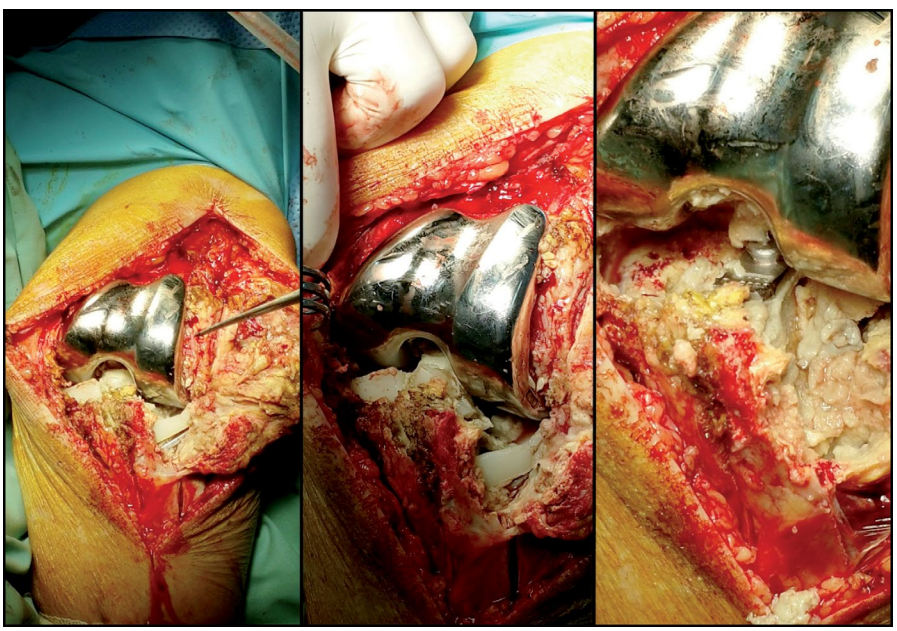

Figure 4. Intraoperative findings

debridement, a total synovectomy and removal of both the tibial and femoral component of the prosthesis, and implanted an antibiotic-impregnated cement spacer. After removing the prosthesis, we assembled the fractured tibial component and marked the fracture areas (Figure 5).

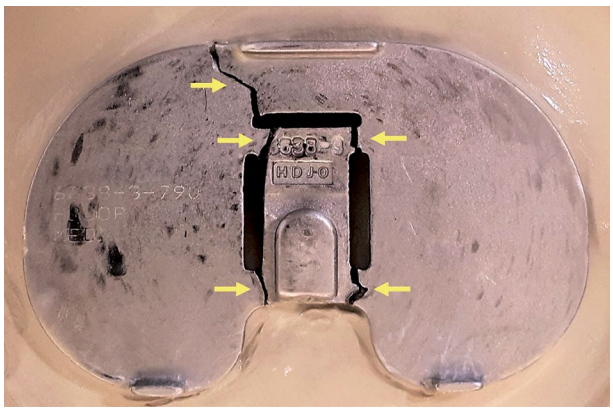

Figure 5. The tibial component assembled and the fracture areas marked.

Figure 6. Standing radiographs after second revision

A microbiological analysis of the swabs taken under the fractured tibial component isolated *Escherichia coli*, so an organism-specific antibiotic was administered during four weeks. After antibiotic administration was finished, a joint aspiration was performed. the fluid was sent for microbiological culture. Joint aspirations were performed once a month in a three-month period. As all microbiological cultures were sterile, the second stage of revision was indicated. A CT scan with a 3D reconstruction was performed preoperatively. Nine months after the first revision, a special megaprosthesis (Modular Rotating Hinge Knee System, Stryker) was implanted in the second stage of revision due to a large defect of the tibia (Figure 6). The procedure went well and in a two-year follow-up the patient was both subjectively and clinically satisfied.

Discussion

Revisions present a complex problem for patients and the surgeon. Causes of TKA revisions seem to differ depending on geographical orientation. Kasahara et al.[9] state in their review that the majority of patients presented for revision due to mechanical wear. This was the result of heavy physical demands placed on the subjects by their lifestyle[9,10]. In a study performed by Le et al.[7], up to 25% of patients were found to have revisions due to infection. This septic loosening is widely established as the number one cause of revisions, although we must not discredit aseptic causes of revision, presenting with better HSS, KS and WOMAC scores preoperatively and postoperatively[11]. Concerning the presented case, it is difficult to say that the isolated bacteria did not contribute to loosening, although we believe it may have been mechanically related, as the patient's erythrocyte sedimentation rate and C-reactive protein values were within the normal range. As previously stated, this complication is extremely rare, however, despite discrepancies between geographic regions, it does have some well-established contributing factors, such as a lack of bone stock and malalignment of the mechanical axis. In this case, the patient had a malalignment in the form of a valgus deformity, which could have caused the laterally broken tibial baseplate. A study performed by Abernethy et al.[12] divided patients into two groups of early revision and

late revision, and found a higher risk ratio in patients with a preoperative varus knee deformity that was not corrected for during surgery. However, the group that presented for revision later had an operative correction of the varus deformity to at least 4 degrees of valgus[12]. A study by Callaghan et al.[13] stated that alignments of the ligaments should not be overlooked in favor of polyethylene sizing, as this does not fix the underlying problem of the knee pathology. In a case report by da Palma et al.[14], both reported cases had a persisting varus deformity leading to increased medial condyle pressure on the polyethylene insert. If we examine the kinematics of gait, we notice the bulk of the pressure is exerted onto the medial aspect; this can be further amplified by an incorrect sizing of the implant, which places further bias on the medial aspect, which can lead to excess polyethylene wear and consequently osteolysis[15,16]. Osteolysis can lead to a loosening of the implant and therefore fracture, resulting in a metallosis reaction and further destruction of the implant and bone[6,10]. This osteolytic reaction is localized in the region of polyethylene wear, as seen in the case reported by Ho et al.[17]. Furthermore, this is consistent with our findings during CT and intraoperative inspection. In TKA revisions, the site of the tibial baseplate breakage corresponded to the area of polyethylene wear, most likely due to the osteolysis and metallosis reactions[10,18]. A study by Nedopil et al.[19] found that after excluding an outlier with a tibial anterior slope of 10°, patients with tibial component failure had a 5° greater posterior slope than those in the control group. In a case reported by Flivik et al.[20], they found that a fracture of the tibial tray was due to the stem being firmly cemented to the tibia. Poor bone quality under the tibial tray in combination with a firmly fixated stem results in an unequal distribution of loading along the tibial tray, which eventually leads to implant fracture[5,9,10,21-23]**.** In our case, we presented a non-cemented tibial baseplate fracture, with an intraoperative finding of a firm attachment of the tibial stem and an excessive osteolytic reaction underneath the fractured lateral tibial baseplate. Another possible cause of implant fracture, mentioned by Flivik et al.[20], is improper design and inadequate manufacturing. In our case, the inadequate design of the prosthesis itself, with a small area of contact between the tibial baseplate and the tibial stem (Figure 5), was one of the possible causes that led to the fracture of the tibial component of the prosthesis. Furthermore, small slots on the tibial baseplate surrounding the tibial stem additionally weakened the tibial component, making the junctions between the tibial baseplate and tibial stem the weakest parts of the prosthesis. As we can see in Figure 5, the tibial component fracture occurred exactly on those junctions; therefore, it seems that in this case improper prosthesis design was most likely the cause of implant fracture.

No matter the cause of implant fracture, these kinds of revisions are particularly demanding for the surgeon and require careful preoperative planning. The Anderson Orthopaedic Research Institute (AORI) classification of bone deficiency during TKA revision is a useful tool which helps to determine the most appropriate method of reconstruction considering the size of the bony defect[24,25]. In our case, according to this classification and considering the size of the bony defect, one of the possible solutions was to implant a megaprosthesis. This kind of revision prostheses are mostly used in orthopedic oncology, but with population aging, more patients have multiple TKA revisions resulting in massive bone defect, so the indication list for this implant is growing[26]. However, in terms of higher complication rates, megaprostheses are still rarely used in such revisions[26,27]. In their study, Holl et al.[26] report only about 20 patients requiring a megaprosthesis for non-oncological indications in a period of 10 years. Eleven patients had complications, including infection in 6 cases. Other complications included fracture, loosening and wound healing problems. A review by Windhager et al.[27] for the use of megaprostheses in periprosthetic fractures in place of multiple TKA revisions, found that revision rates ranged from 0% to 55%, primarily due to mechanical and non-mechanical reasons. Mortality ranged from 6.6% after 1 year to 45% after 34 months. The review concluded that there were benefits of using megaprostheses, such as restoration of stability, KSS improvement, pain relief and compensation for bone loss[27].

Conclusion

This case presented a rare complication of total knee arthroplasty, along with potential causes and solutions for complicated cases of such situations. The mechanisms and risk factors regarding TKA failure are well known, which is why it is important to avoid and alleviate the contributing factors. Even when it seems as though every measure was taken to avoid unnecessary risks and the operation was successfully performed, some patients are still not satisfied, as later complications are always present. Therefore, it is imperative to follow up with the patient and listen to their complaints, as this can lead to an earlier diagnosis of TKA malfunction and a less demanding revision surgery.

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SAŽETAK

MULTIFRAGMENTARNI PRIJELOM TIBIJALNE KOMPONENTE: SLUČAJ RIJETKE KOMPLIKACIJE NAKON POTPUNE ENDOPROTEZE KOLJENA

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Ugradnja totalne endoproteze koljena kirurški je postupak indiciran u slučajevima teške artroze koljena s jakim bolovima koji ne reagiraju na konzervativne modalitete liječenja. Iako je ugradnja totalne endoproteze rutinski operacijski postupak, i dalje postoje komplikacije koje mogu dovesti do katastrofalnih rezultata. Prijelom implantata jedna je od takvih komplikacija. Prikazujemo slučaj 74-godišnje bolesnice kod koje je nakon ugradnje potpune endoproteze koljena došlo do rijetke komplikacije prijeloma tibijalne komponente endoproteze. Donosimo i pregled mogućih uzroka takvog ishoda kao i mogućnosti liječenja.

Ključne riječi: *ugradnja endoproteze koljena; komplikacija; prijelom implantata*