Case Report

An Alternative Technique to Treat Tibia Bone Loss in Revision Total Knee Arthroplasty

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The author report a case of aseptic loosening total knee arthroplasty with AORI type IIB tibia bone defect that were revived by an alternative technique using MBT revision tray and Metaphyseal Sleeves. The uncontained defect were converted to contained defect by metal mesh fixation on tibia circumferentially and 40 grams of tricalcium phosphate mixed with 1 cc of demineralized bone matrix (DBM) were impacted into defect. Patient was regularly followed-up and ambulated by non-weight bearing for one year. Knee Society Score was improved from 50 at the index of revision surgery to 85 at 24 months at last follow up. Flexion of right knee was 105 degree.

Keywords: *Metal mesh, Tricalcium phosphate, Bone loss, Revision total knee arthroplasty, Demineralized bone matrix*

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The increasing number of primary total knee arthroplasty (TKA) procedures being performed has been accompanied by an increasing number of complex revision TKAs. Managing complicated revision TKA requires stable construct designed to address ligamentous laxity and bone loss that can be challenging. Etiologies of bone loss can be from osteolysis infection, stress shielding, aseptic loosening[1] and can be occurred during the process of implant removal and debridement.

Defects can be categorized as contained or uncontained. Uncontained defects can be further categorized as circumferential or non-circumferential. The mostly used classification of bone loss is Anderson Orthopaedic Research Institute (AORI)[2] classification which categorized bone loss into three groups based on the severity of bone deficiency encountered during revision surgery.

Management of bone defects can be done by using cement, cement with screws, impacted bone graft, metal augments, structural allograft and endoprosthesis depend on size, location and containment of defects.

The author report a case of alternative technique to treat large segmental tibia bone loss.

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Case Report

A 66 years old woman complaint about her right knee pain for 4 months. She had done right total knee replacement 11 years ago and followed by left total knee replacement one year later. Two years after right total knee replacement, she had aseptic pesanserinus bursitis and was treated by anti-inflammatory drugs and aspiration but did not response. Finally, she was treated by excision bursa and got improvement obviously. Two years later, she had right knee pain again. Radiograph shown loosening with medial tibia plateau bone loss. Septic workups were negative then she got revision total knee replacement by PFC® SIGMA® TC3 SYSTEMS with metal step wedge augments 10 mm at lateral tibia plateau and 15 mm at medial tibia plateau. Femoral bone loss augments were done using step wedge 8 mm distally both sides, 4 mm posterior step wedge augments both sides and cementless press-fit extension stems both femur and tibia. After surgery she still had occasional knee pain.

Three years ago she had progressive right knee pain, radiograph shown aseptic loosening of tibia prosthesis but femoral prosthesis still intact as Fig. 1. There was large bone defect at metaphysis of tibia. She was diagnosed as aseptic loosening of total knee arthroplasty and was planned to do revision surgery. Intra-operative, femur prosthesis was well fixed and did not removed, tibia prosthesis and all cement was removed and debridement was done. Bone defect was inspected and classified to be type IIB referring to

AORI classification.

To manage bone defect, we used metal mesh to convert uncontained to contained defect and circumferentially fixed on tibia by small screws fixation as Fig. 2. Then used 40 gm of tricalcium phosphate grafts to mix with 1 cc of Bonefuse™ and fill to the defects. M.B.T. revision tray with cementless press-fit stem and Metaphyseal Sleeves was used. This construction was done without using bone cement as Fig. 3.

After the operation, patient needed to protect her weight by non-weight bearing with walker for one year. After one year, radiographs shown that bone grafts substitute were consolidated with signs of remodeling. So she started to ambulate without crutches and weight bearing as tolerate. Patient was regular followed-up for two years. Currently, she can walk without gait aids. Knee Society Score was 50 before revision surgery and improved to 85 at 24 months.

Fig. 1 Pre-operative radiograph shows lossening of tibia prosthesis which will left a large metaphyseal bone defect after removed implants.

Fig. 2 Intra-operative photograph shown that metaphyseal tibia defect was managed by changing uncontained to contained defect using metal mesh.

Discussion

Principles to consider in bone loss management are defect size, location and containment. One widely recognized method for categorizing defects is the Anderson Orthopaedic Research Institute (AORI) classification[2]. Defects may be further classified as Type I-contained with metaphyseal bone intact, in which restoration of joint line can be accomplished without bone grafting or augmentation; Type II-loss of cancellous metaphyseal bone requiring reconstruction with cement fill, prosthetic augment, bone graft; Type II is further divided to Type IIA bone loss involve one tibia condyle, Type IIB bone loss involve both tibia condyles. Type III-deficient metaphyseal segment compromising a major portion of either femoral condyles or tibia plateau requiring reconstruction with structural bone grafts, metaphyseal cone or sleeves and endoprosthesis.

Intra-operative assessment found that there was circumferential metaphyseal segmental tibia bone loss involved both tibia plateau corresponded to Type IIB bone defects in AORI classification. The treatment options for bone defect in this patient would be structural allograft that be available in large institute but it is not available in author hospital. Another option was to use metaphyseal cone but planning in this patient was to revive tibia only and metaphyseal cone is not compatible to use with other products so author decided to use Metaphyseal Sleeves and MBT Revision Tray but this combination were not enough to treat metaphyseal segmental bone loss in this case.

There was a report that used metal mesh and impaction bone grafts to convert uncontained to contained bone defect with good results. Lonner JH1

Fig. 3 An post-operative radiograph show metaphysis segmental tibia bone loss, type IIB AORI classification was managed by circumferential metal mesh fixation and defect was fills by impaction of tricalcium phosphate with DBM.

et al[3] reported good results of 17 revision total knee arthroplasties in 14 patients in whom large uncontained defects were treated with impaction allografting and molded wire mesh for containment. There are no study report using metal mesh and bone grafts substitute to treat large bone defects in total knee arthroplasty. Autologous cancellous grafts have osteogenic, osteoconductive, and osteoinductive properties that made it ideally in management bone defects[4]. The advantage of autologous cancellous grafts are their excellent fusion rate, low risk of transmitting disease and histocompatibility. However, there is a limited quantity of autogenous graft and there is the potential of donor site morbidity. In addition, the harvesting of autogenous bone is associated with a rate of major complications of 8.6% and a rate of minor complications of 20.6%[5]. Another problem is that enough autogenous grafts may not be available, especially if there is massive segmental bone loss as in this patient. For these reasons, it is important to have various options available.

Morselized and cancellous allografts are osteoconductive and provide some mechanical support, mainly in compression[4]. It is also useful to augment autogenous cancellous bone and to fill larger defects when supply of autogenous bone is limited. Allograft bone is associated with a very small risk of infectious disease transmission.

Tricalcium phosphate ceramics is used as osteoconductive matrices. The material structure of ceramics is derived from individual crystals of a highly oxidized substance that have been fused together at the crystal gain boundaries by a high temperature process called "sintering"[6]. Ceramics are brittle and have poor tensile strength. It should be placed in intact bone or rigidity stabilized bone in order to protect ceramic from shear stresses, and they should be tightly packed in to the adjacent to maximize ingrowth[7]. Calcium phosphate do not elicit a foreign-body reaction and are well tolerated by host tissues.

Tricalcium phosphate undergoes partial conversion to hydroxyapatite once it is implanted into the body[8]. Tricalcium phosphate is more porous and is resorbed more faster than hydroxyapatite[6]. After conversion, the hydroxyapatite is resorbed slowly therefore large segments of hydroxyapatite remain in place for years. Bucholz et al[7] showed that tricalcium phosphate is effective for filling bone defects resulting from trauma, benign tumors, and cysts.

Bonefuse™ composed of human derived demineralized bone matrix (DBM) with hydroxyapatite granule. By process of mild acid extraction from bone leaves behind growth factors, non-collagenous protein, collagen and provides a suitable framework for cells to populate and produce new bone. DBM is an excellent grafting material with which to induced bone formation within contained, stable skeletal defects[9,10]. When adding DBM with tricalcium phosphate may provide osteoinductive property to tricalcium phosphate and may increase incorporation rate of bone grafts substitute.

Because of large segmental bone defect that could not be filled by Metaphyseal Sleeves and lack of autologous cancellous grafts and allografts to fill defect, author convert remaining uncontained to contained defect by using metal mesh fixed on tibia circumferentially and filled defect by tricalcium phosphate and DBM. Cementless press-fit extension stem was used to provide stability to the construction and bypass load to diaphysis bone. The reconstruction was uncemented to provide optimal change of bone ingrowth. Early post-operation, stability was provided by press-fit of stem to tibia diaphysis alone. Protection weight was needed while waiting for bone incorporation. Late stability was provided by osseo-integration of newly bone to Metaphyseal Sleeves.

After 1 year, some bone grafts substitute resorbed and remodeling was seen in load transmission area. There was bone graft substitute resorbtion beneath tibia base plate too but patient could walked full weight bearing without any pain that showed there was no movement of the reconstruction.

Two years postoperative, radiographs showed decrease opaque of bone grafts substitute and seen some trabecular line within as Fig. 4. The reconstruction was stable, no radiolucent line was seen around extension stem. Range of motion is 105/0/0 as Fig. 5 and there are no instability in both sagittal and coronal plane. Patient could walked without pain.

Fig. 4 Two years post-operation, bone grafts substitute showed some resorption and remodeling.

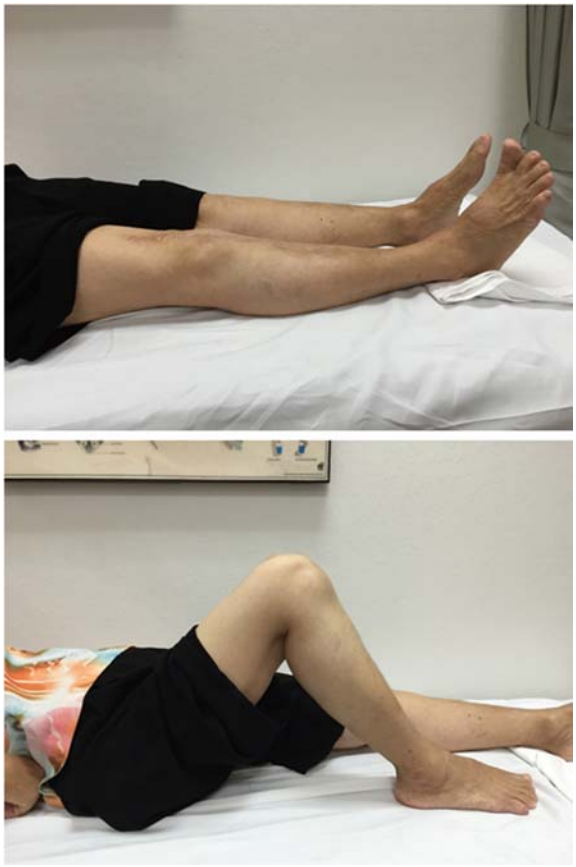

Fig. 5 In 24 month post-operation, patient can walk with full weight bearing without pain. Range of motion is 105/0/0. There are no instability both sagittal and coronal plane.

The pros of this treatment technique is it can convert large segmental bone defect to contained one by using metal mesh and fill it with bone graft substitute that usually be available in general hospital unlike structural allograft that is available only in large tertiary hospital. When this construct is consolidate and remodeling, it would give a natural bone support and provide easier to do further reconstructive surgery. The cons of this technique are the potential of host response to heal bone defect can be vary and duration that patient need to protect weight bearing is long. Failure can occur if patient put on weight before healing of the reconstruction unit.

Conclusion

The reconstruction technique using metal mesh and tricalcium phosphate with DBM is an alternative method to treat large segmental tibia defect in AORI type IIB and also provide new bone formation but it need to protect weight before healing of the construction unit. The short term results of this technique is good. Knee Society Score improve from poor to excellent. However a longer followed-up period is needed to warrant this technique.

What is already known in this topic?

The standard technique for treatment of bone loss in revision total knee arthroplasty.

What this study adds?

This study report an alternative technique in management of massive segmental tibia bone loss.

Potential conflicts of interest

None.

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รายงานผู้ป่วย การผ่าตัดแก้ไขภาวะกระดูกขาส่วนที่สูญหายในการผ่าตัดข้อเข่าเทียมโดยใช้วิธีทางเลือกใหม่

คมสัน ปลั่งศิริ

ผู้นิพนธ์นำเสนอเทคนิคการผ่าตัดรักษาข้อเข่าเทียมหลวมและมีการสูญหายของเนื้อกระดูกขาในระดับ AORI IIB โดยการใช้ Mobile Revision Tray ร่วมกับ Metaphyseal Sleeves โดยไม่ใช้ซีเมนต์ยึดกระดูก ส่วนของเนื้อกระดูกที่สูญหายไปใช้ metal mesh ยึดกับกระดูกขาและล้อมโดยรอบ ในส่วนของช่องว่างใช้ tricalcium phosphate 40 กรัมผสมรวมกับ demineralrized bone matrix จำนวน 1 ซีซี อัดให้แน่น ผู้ป่วยได้รับการติดตามอาการอย่างสม่ำเสมอเป็นเวลา 24 เดือน ผล Knee Society Score ดีขึ้นจาก 50 คะแนนก่อนผ่าตัดเป็น 85 คะแนนภายในระยะเวลา 24 เดือน พิสัยของการเคลื่อนไหวของข้อเข่าได้ 105 องศา
