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Primary total knee replacement in grade 4 osteoarthritis with bone defect of bilateral knee joint: Case report

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Abstract
While tackling with bone deficiencies in the context of total knee arthroplasty, it is imperative for the arthroplasty surgeon to arm himself with an in-depth knowledge on the various management options available and to use the right option for the right type of defect in the right patient. this case report is on the various options available and discuss the evolving concepts and recent trends with regard to the implications and treatment of bone deficiencies, in primary total knee arthroplasty. Relevant literature is evaluated with specific focus on the modality used for managing a defect, their clinical and radiological outcomes and failure rates. Out of various classifications described, Anderson Orthopedic Research Institute (AORI) system is universally employed to classify the bone defects. The currently available management options include more tibial resection, the use of bone cement to fill the defect, with or without augmentation with screws, bone grafting which may be autograft or allograft, metal augments, metaphyseal cones and sleeves. There is no single option which can be applied universally; each has its own advantages, disadvantages and specific indications with regard to application in specific types of defects, in specific patients. In This specific case report, we have a patient 75yr old man with Grade 4 Osteoarthritis B/L knee joint with posteromedial bone defect, Underwent primary total knee arthroplasty with augmentation of bone defect with Autograft Taken from femoral cuts and intercondylar box cut graft, fixed with screws along with bone cement used for stabilization of tibial component with metaphyseal stem.

Keywords: Total knee replacement, managing bone defects

Introduction
Patients with advanced osteoarthritis of knee requiring total knee arthroplasty (TKA) in our population are usually associated with moderate to severe varus deformity with bone defects in tibia involving the medial compartment as majority of them report to hospital at a late stage. Among the various challenges faced by the arthroplasty surgeon, bone defects or bone loss, especially on tibial side, is of prime importance. There may be several causes of bone defects, such as secondary to trauma, osteonecrosis, infections, previous osteotomy, neoplastic conditions etc., but the most common cause is usually an advanced stage of osteoarthritis (OA) of knee. About 29% of the people in India are estimated to be suffering from some form of OA knee [1]. Bone loss is a common occurrence especially in the posteromedial aspect of the tibial condyle in end-stage OA of the knee due to degenerative erosions and may also be seen on the femoral condyles. These defects, if not addressed properly, may lead to a compromised bone-implant interface causing malalignment of the implants and hence a postoperative deformity, increased complications and need for revision surgeries. This Case Report
deals with the Total knee Replacement Done at MDM Hospital under Dr. S.N Medical College, orthopedics department on 30th January 2022 of 75yr old man with severe grade 4 O.A bilateral knee joint with postero - medial bone defect In bilateral tibial condyle, managed with total knee replacement with autologous bone graft taken from femoral cuts and fixed with cancellous compression screws and bone cement.

Classification
Various classification of bone defects have been reported in the literature, based on size, severity and location of the bone deficiencies which may help in accurate preoperative planning for management, predicting outcomes and providing guidelines on treatment

However, controversy exists among the various classification systems for bone defects. Anderson Orthopedic Research Institute (AORI) classification, based primarily on the size of the bone defect present in tibia and femur, is the most useful and widely used system (Table 1).

Table 1: Anderson Orthopaedic Research Institute (AORI) classification of bone defects

Type	Severity of bone defects in tibia (T) and femur (1)
1 (T1 and Fl)	Minor bone defect without compromising the stability of a component
2A (T2A and F2A)	Metaphyseal bone damage and cancellous bone loss in one femoral condyle/tibial plateau requiring reconstruction to maintain implant stability
2B (T2B and F2B)	Metaphyseal bone damage and cancellous bone loss in both femoral condyles/tibial plateau
3 (T3 and F3)	Significant cancellous metaphyseal bone loss compromising a major portion of either femoral condyles or tibial plateau, occasionally associated with patellar tendon or col-lateral ligament detachment_

Bone deficiencies are categorized into contained (central) defects, with an intact bony rim which acts as a support for the implant, most commonly seen in OA knees with valgus deformity, and uncontained (peripheral) defects, often seen in varus knees which offer no peripheral support for the implant [2]. Preoperative templating will give a rough idea about the possible need to augment a bone defect. After drawing the line of expected resection of the tibial plateau in orthogonal radiographs, any defect more than 10 mm in its largest dimension usually needs to be addressed. Intra-operatively, a bone defect should be augmented if implant instability is observed during the trial reduction. The knee is subjected to full range of motion in order to assess the stability of the trial reduction. This maneuver will reveal any displacement at the bone-trial implant interface which is duly noted. This instability during trial reduction is observed if bone defect involves 40% or more of the circumference of the resected bone with trial implant lying unsupported by host bone [3].

The various options for management of bone defects include under sizing of tibial base plate, bone cement only or with screws, autograft, structural or morselized allograft, metal augments, porous tantalum cones and metaphyseal sleeves (Fig. 1).

In shallow defects of < 10mm AORI Type 1, More Tibial resection with thicker polyethylene insert is applied [3]. In primary TKA, the maximum amount of bone removed from the level of the original lateral tibial subchondral plate should not exceed 10 mm or 5 mm from the original medial subchondral plate [4]. When bone deficiencies are more than 10 mm, the tibia should not be cut to the level of the deficit. It has been demonstrated that the strength of osseous support is reduced by a distal tibial resection with the resultant use of a narrower tibial component. This further reduces the area of support with increased loading [5–7].

Bone cement only may be used to primarily fill defects less than 5 mm in their largest dimension after the proximal tibial resection. In defects of 5–10 mm (AORI type 1), cancellous screws may be used to stabilize the implant while the cement is setting, which help to prevent component malposition [3]. Cement should not be used as a primary modality in larger defects, i.e. more than 10 mm as the construct with excessive cement even if augmented by screws is weak and unstable mechanically. Fragmentation of cement and early implant failure may be the resultant outcome in such cases [8–10]. Moreover, thermal necrosis and shrinkage of volume of bone cement during polymerisation and lamination may occur due to release of great amount of heat from the large volume of cement used. Radiolucent lines are frequently observed at the bone-cement interface [11].

Autograft technique uses bone pieces harvested from the same individual, from the resected femoral condyles or from the iliac crest, to correct a bone defect. This is a good technique for relatively small bone defects, as the amount of bone graft that can be obtained is limited. Liu *et al.* [12] reported the results of autografts used from resected distal femoral bone which was fixed with screws to manage the bone deficiency. This helped in restoration of knee stability and its mechanical axis. At 6 to 9 years of follow-up, statistically significant improvement was observed from the preoperative Knee Society Score (KSS). Another technique of tibial flip autograft has been described by Franceschina and Swienckowski [13].

The purpose of using structural all to tackle bone defects is to provide maximum stability at graft–host bone interface and achieve a stable surface for fxation of implant. The opposing surfaces of the graft and defect are thoroughly debrided to expose bleeding bone. Conversion of the oblique peripheral defects into rectangular space with vertical and horizontal surfaces before repair has been demonstrated to improve stability for the tibial component fxation [14]. The stepped patterns have also a biological advantage since it allows improving the contact area of the host–graft construct maximising the probability of graft incorporation [15, 16]. The graft can be stabilised with 2–3 countersunk cancellous compression screws [17, 18].

Stem extenders may be considered for larger defects to decrease proximal axial load of the reconstructed area [8, 14].

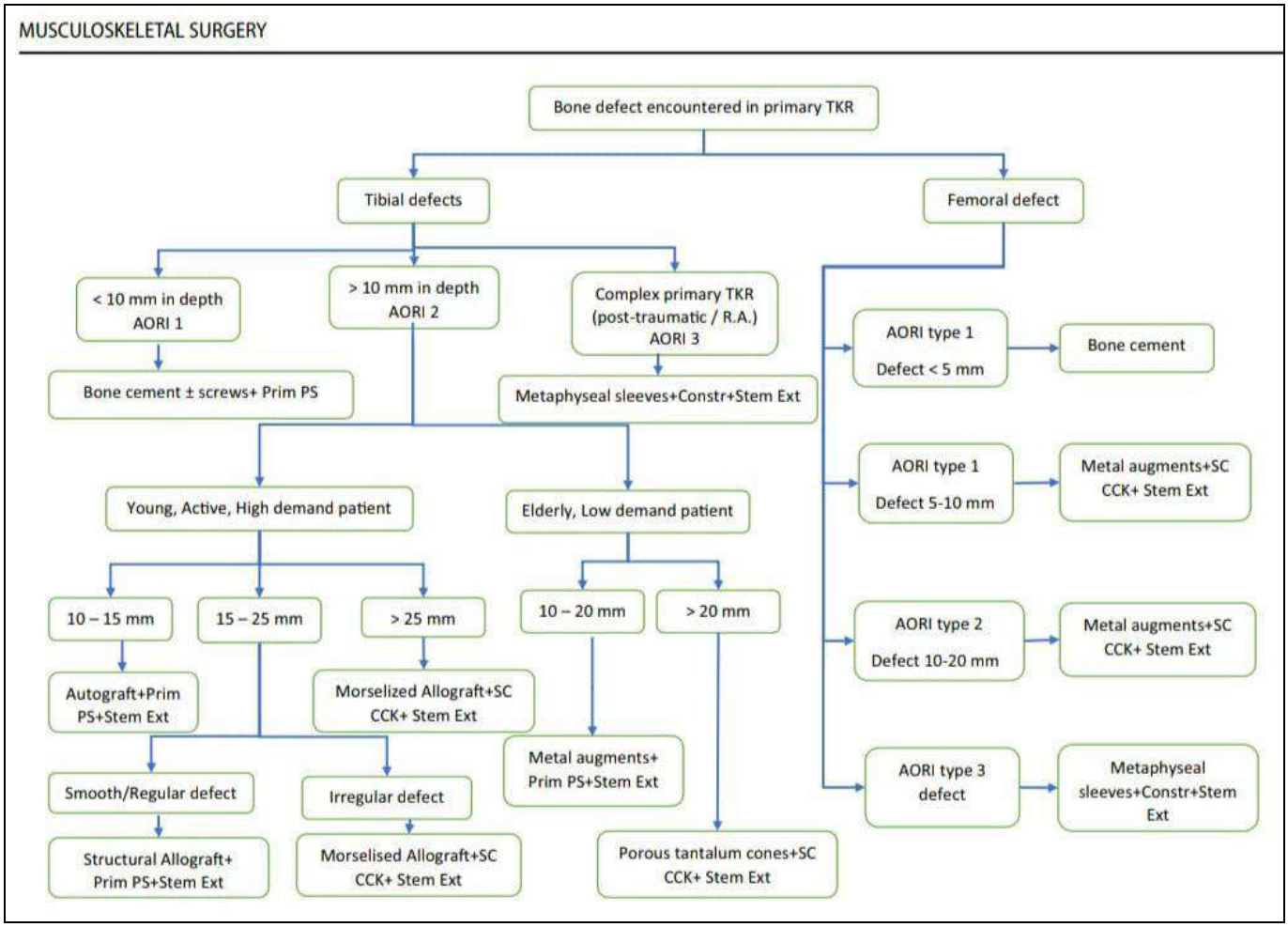

Fig 1: Flow chart depicting the management option for various types of bone defects in primary TKA

Case Study

A 75yr old man presented to us with bilateral knee pain, severe deformity around both the knee joints and unable to wear weight and do his day today activities from past 1 year. Patient was farmer by his profession and stop all the activities since last 2 years. and do not had any co-morbidities and any other treatment history and was physically fit to underwent any surgery.

On physical examination of bilateral knee joint, we got the following measurements.

Table 2: On physical examination of bilateral knee joint, we got the following measurements

Dimensions	Right	Left
Fixed flexion deformity	10'degree	15'degree
VARUS	35' degree LAX	45'degree LAX
Postero-medial bone defect	35mm	50mm

His pre operative Oxford knee score [19] was 9 out of 60, indicating the severe knee arthritis and requirement of surgical intervention.

while his Knee Society Function Score [20] was 0.

According to Anderson Orthopedic Research Institute (AORI) classification, based primarily on the size of the bone defect present in tibia and femur, our patient had the bone defect of type 2A(T2A) in bilateral Knee joint in posteromedial Tibial plateau.

Pre-operative Xray of bilateral knee joint.

Fig 2: Pre operative x-ray of right and left side bilateral knee joint AP and Latera View

Fig 3: Pre-Operative Pic of gross varus deformity of B/L lower limb of patient

Material and methods

Material used in this case was.

a) Total knee arthroplasty implant :- femoral component, tibial component, polyethyelene insert, metaphyseal Stem for tibia (De-puy)
b) Bone cement (Stryker)
c) Cancellous compression screw
d) Autograft harvested from the same individual, from the resected femoral condyles.

Method

TKA was offered and was agreed upon after informed consent.

Midline incision was made and followed by medial para patellar approach.

Patient had bone defect of 2A(T2A) in bilateral tibial plateau and bone deficiency was more than 10 mm, the tibia was not be cut to the level of the deficit. It has been demonstrated that the strength of osseous support is reduced by a distal tibial resection with the resultant use of a narrower tibial component. This further reduces the area of support with increased loading. [1] After the proximal tibial cut is made at 10 mm depth from the unaffected tibial condyle, tibial surface is prepared to accept the tibial base tray. The sclerotic base of the defect is cut to expose a fat, cancellous bony surface, and the concave, irregular defect is converted to a flat one by minimal bone removal with a saw. By Autograft technique, bone pieces harvested from the same individual from the resected femoral condyles used to correct the bone defect of bilateral tibial plateau. Autografts used from resected distal femoral bone was fixed with cancellous screws to manage the bone deficiency. This helped in restoration of knee stability and its mechanical axis the trial tibial component with intramedullary stem is assembled and inserted and a trial reduction is done, verifying alignment, stability and patellar tracking. After lavage, the real components are assembled and cemented.

Post -Operative Day 1 patient allowed to partial weight wear with the help of walker and physiotherapy for the range of motion started for bilateral knee joint from 0’ – 90’ and then 0’ to maximal flexion as tolerated from POD 2 onwards and then full weight wear allowed.

Post op FFD, Varus Deformity corrected completely.

after 3 month of TKA, Patient is happy with functional outcome, with R.O.M B/L knee 0’ to 90’ with his knee society score(KS) is 65 and Oxford knee score (OKS) was 35. Xray shows satisfactory position and alignment.

Post-operative x-ray of bilateral knee joint

Fig 4: Immediate Post operative x-ray of right and left side bilateral knee joint AP and Lateral View

Fig 5: post op x-ray after 3 months of primary T.K.A of left and right knee joint AP-Lateral view

Fig 6: Post op after 3 months

Fig 7: Immediate post op on P.O.D 3

3. Discussion

Bone defects less than 10 mm or AORI type 1 can be addressed using bone cement alone (< 5–6 mm) or (6–10 mm) with screws. AORI type 1 defects with intact collateral ligaments can be managed with primary posterior stabilized (PS) TKA implants. In these circumstances, it is possible to perform standard tibial bone resections, with bone cement or/and screws AORI type 2 (10–25 mm) defects should be managed by structural bone grafts (auto- or allograft) in the young, active patient and metal block augmentation[21-23] in elderly, low demand individuals along with stem extender.

AORI type 2 (>25 mm) are better managed with impaction bone grafting and with porous tantalum[24-26] cones in elderly along with semi constrained CCK implants, stem extender and constrained insert.

In type T2A AORI bone defects with intact collateral ligaments, primary PS implant with stem extender can be used Fig. 4 a Postoperative X-ray of knee anteroposterior view showing management of AORI type 2 defect of>20 mm by bone graft, screw medially and tibial extender. b Postoperative X-ray of knee lateral view showing management of AORI type 2 defect of>20 mm by a tibial extender, along with either bone grafts fixed with screws.

In type 2A/2B AORI bone defects with insufficient collateral ligaments, semi constrained CCK implant with stem extender and constrained insert should be used along with metallic wedge augmentation or porous tantalum cones. CCK are semi constrained implants, which provide an excellent alternative to the hinged prostheses in cases of insufficient ligaments and moderate severity bone loss (AORI type 2). In CCK prostheses, constrained inserts can be used which are characterized by a large and long tibial post which engages in the large, deep intercondylar cam of the femoral components, thus ensuring medio-lateral and rotational stability. In moderate (type 2) or severe (type 3 AORI) bone defects with complete disruption or absence of the collateral ligaments, constrained or modern hinged implants with fixed or mobile.

AORI type 3 defects may be addressed using porous metaphyseal sleeves and constrained or hinged implants.

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