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Educational Article

Techniques in the management of juxta-articular aggressive and recurrent giant cell tumors around the knee

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Abstract

Aim: Juxta-articular aggressive and recurrent giant cell tumors around the knee pose difficulties in management. This article reviews current problems and options in the management of these giant cell tumors.
Methods: A systematic search was performed on juxta-articular aggressive and recurrent giant cell tumor. Additional information was retrieved from hand searching the literature and from relevant congress proceedings. We addressed the following issues: general consensus on early diagnosis and techniques in its management. In particular, we describe our results with resection arthrodesis performed combining the benefits of both interlocking intramedullary nail and Ilizarov fixator in the management of these tumors around the knee.
Results: Mean operative age of the 22 patients undergoing resection arthrodesis was 35.63 years. Seven lesions were in the tibia and fifteen in the femur. Mean length of the bone defect was 12.34 cm. The mean external fixator index was 7.44 days/cm and the distraction index was 7.88 days/cm. Mean period of follow-up for the patients was 64.5 months. The function of the affected limb was rated excellent in 10 and good and fair in six patients each as per Enneking criteria. No local recurrence of tumor was seen. Seven complications occurred in five patients.
Conclusion: Two-ring construct, bifocal bone transport, and early definite plate osteosynthesis with additional bone grafting of the docking site at the end of distraction even before consolidation of the regenerate helps to reduce the problems of pin tract infections drastically. Thin-diameter long intramedullary nail in addition to preserving the endosteal blood supply also prevents mal-alignment of the regenerate. Thus resection arthrodesis using interlocking intramedullary nail and bone transport using Ilizarov fixator is cost effective and effective in achieving the desired goals of reconstruction with least complications in selected patients with specific indications.

Keywords: Giant cell tumor; Aggressive; Recurrence; Knee; Juxta-articular

Introduction

Giant cell tumor (GCT) of bone was first described in 1940 by Jaffe, Lichtenstein and Portis as a distinct clinicopathological entity. GCT is defined as a primary central tumor of bone, with specific predilection of age (20–40 years) and location (juxta-articular, most commonly distal femur and proximal tibia), composed of mononuclear cells and multinucleated giant cells with a variable and unpredictable potential for growth.[1,2] Giant cell tumor of bone is one of the most common primary bone tumors in young adults. It comprises of 5% of all primary bone tumors.[1] The course of an untreated GCT (or its local recurrence and 'benign' metastasis) is very variable.[2] It usually behaves in a benign manner but has a prominent tendency to local recurrence both in the bone and in the surrounding soft tissues if contaminated during surgery. It rarely gives rise to pulmonary metastases.[3–5] and very rarely transforms into a high-grade sarcoma spontaneously following radiation therapy.[6] Our current theme being the description of surgical techniques in the management of aggressive and recurrent GCT, the milder varieties of uncomplicated GCT have been excluded accordingly from the discussion.

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Aggressive GCT

Enneking[7] and Campanacci[8] staging based on a combination of clinical, radiological and histological features has been widely accepted in the management of GCT. Stage 3 GCT is considered aggressive tumor which amounts to 15–20% in primary GCT and is more frequent in local recurrences (Table 1). Clinically the symptoms are those of an expanded, aggressive lesion, whose course is rapidly progressive. There is a high incidence of pathological fractures.[9] The imaging shows an osteolysis (usually extensive) with ill-defined limits, destruction of the cortex, bulging of the tumor into the soft tissues without containment by a reactive bone rim (T1 or T2), intense isotope uptake well beyond the limits of the tumor, intense tumoral and peritumoral hypervascularity. Intra-articular extension is rare because the subchondral bone usually remains intact. Matrix production is usually not evident within the bone but often is evident if there is soft tissue extension, soft tissue recurrence, or pulmonary metastasis. The histology is grade 2 or 2+ in these aggressive tumors.[8] MRI is useful to determine the extent of the lesion both within the bone and in the soft tissues. On MRI, the lesion is usually dark on T1-weighted images and bright on T2-weighted images. Most often pathological fractures are associated with an aggressive GCT. However, FNAC (Fine Needle Aspiration Cytology) is a must before planning surgery. FNAC has been a useful tool of proven value in surgical staging of GCT.[10]

Recurrent GCT

The chances of recurrence have varied to a large extent in different studies quoted in literature.[11–15] But this is on the decline by virtue of better delineation of the tumor extent by MRI and also the improved surgical techniques. The use of high speed burrs and copious irrigation of the cavity had reduced the chance of recurrence in 'simple' curettage. 'Extended' curettage which includes the use of adjuvants like liquid nitrogen, phenol, bone cement, or thermal cautery (argon beam coagulator) has further reduced the risk of recurrences. Although each adjuvant treatment has its proponents, no study has proved that any one is superior, with each having inherent advantages and disadvantages. The quoted recurrence rates are up to 60% after simple curettage alone, 40–60% following standard curettage and bone grafting, 0–40% with curettage using high speed burrs and bone grafting and 10% after adjuvant therapy with phenol, bone cement, or liquid nitrogen cryotherapy.[11–15] A recent study reports equal recurrence rates after curettage and bone grafting when compared to other methods.[11] The rate of recurrence increases sequentially with histological staging being 7% in 'quiescent', 26% in 'active', and 41% in 'aggressive' tumors.

Most of the reported recurrences occur within a year after surgery,[14,16,17] but can occur up to 20 years. The recurrence can be detected by the evidence of relapse of clinical symptoms and progressive radiological lytic lesion in the bone beyond the confines of the primary tumor (Table 2). The diagnosis is difficult radiologically in case of bone grafted tumors as compared to those filled with bone cement. The use of bone cement in the primary treatment makes detection of recurrence easier as lysis always occurs on the extralesional side of the cement–bone interface.[16] The width of the normal lucent rim surrounding the cementoma has been described as only 1–2 mm.[18] Recurrence is to be suspected radiologically when the lucent rim around the cementoma exceeds 5 mm at any point on either of the two standard projections. This will then be followed by progressive lucency.

The serial radiographs and CT/MRI scans in doubtful cases are of immense value in the early detection of recurrence following the primary surgery. MRI is particularly helpful in assessing joint involvement although care should

Table 1
Corroborative evidences toward the diagnosis of aggressive giant cell tumor

Clinical indicators
Rapid growth.
Disproportionate pain.
Pathological fracture.
Evidence of pulmonary metastasis.
Radiographic evidences
Extensive osteolysis with ill-defined limits.
Cortical erosions and bone enlargement without periosteal reaction.
Loss of intralesional septations.
Soft tissue/joint infiltration.
Bone scan evidences
Intense isotope uptake well beyond the limits of the tumor.
Tumoral and peritumoral intense hypervascularity.
Presence of multicentric GCT.
MRI scan evidence
Breach of the articular cartilage.
Cortical break and soft tissue extension.
FNAC
Grade 2 or 2+ histology.

Table 2
Indicators of recurrence of GCT following primary surgery

Clinical features
Relapse of clinical symptoms.
Radiological evidence
If bone grafted primarily
Lytic lesions beyond the confines of the primary tumor.
If cemented primarily
Lysis beyond 5 mm at any point of cementoma.
CT/MRI scan evidence
Fresh appearance of the tumor as
High signal intensity in T2-weighted images and
Low signal intensity in T1-weighted images.
FNAC
Grade 2 or 2+ histology.

be taken in the interpretation of effusions which may be reactive or due to infarction. MRI of lesions indicating recurrence on plain radiography typically shows the fresh tumor as a high signal on T2-weighted images and a low signal on T1-weighted images. Cementomas do not degrade MR images as much as CT scans, in which there is substantial beam-hardening artifact.[17] They appear as a signal void on all MRI sequences. MRI will also distinguish recurrent tumor from focal osteoporosis resulting from altered stress since the latter should not result in signal changes around the cementoma. Production of the sclerotic rim is probably a normal host response to physical and thermal damage during cementing. The formation of a complete sclerotic rim around the cement suggests recurrence to be unlikely.

Surgeries for juxta-articular aggressive and/or recurrent GCT around the knee

There has been a remarkable development in the surgical management of the aggressive and recurrent juxta-articular giant cell tumors with a goal to achieve preservation of joint function. The survival rates after wide resection of these locally aggressive GCT are very encouraging. The morbidity and mortality after successful surgical wide resection of these tumors is negligible. Because of all the above reasons, resection of the tumor with a goal to achieve wide surgical margin has been accepted as the standard treatment today. But it has always been a challenge to reconstruct the resected gap especially across the joints. The ideal reconstruction should have near-normal function, biological affinity, resistance to infection, sufficient biomechanical strength, and durability. The choice of reconstruction after resection of a tumor about the knee is based on many factors, including the type and extent of the tumor, the amount of tissue that must be removed to achieve the desired margin, the experience of the surgeon with the various reconstructive procedures, an understanding of the advantages and disadvantages of the reconstructive operations, and the needs and preferences of the patient. Joint preservation has been considered as the goal in the treatment of juxta-articular GCT. When the joint preservation is not possible due to tumor related factors, resection arthrodesis can be taken as a limb salvaging procedure. The surgeries for these juxta-articular aggressive and recurrent giant cell tumors can be classified as in Table 3.

Table 3
Surgical options in the management of aggressive and/or recurrent GCT around the knee

(1) Joint salvaging surgeries (saves the patient's own joint).
(2) Joint preserving surgeries (uses the artificial joints)
  (a) Custom megaendoprosthesis.
  (b) Osteoarticular allograft transplantation.
  (c) Allograft and endoprosthesis composite.
(3) Joint sacrificing surgeries (resection arthrodesis)
  (a) Intercalary bone grafting
    - Autogenous bone graft.
    - Tumor graft.
    - Allograft (deep frozen/freeze dried).
    - Bone substitutes.
    - Vascularised fibular graft.
  (b) Intramedullary nail with bone grafting
    - Autogenous bone graft – Enneking and Sherley Turnplasty procedure.
    - Tumor graft.
    - Allograft (deep frozen/freeze dried).
    - Vascularised fibular graft.
  (c) Distraction histogenesis
    - Ring fixators.
    - Modular fixators.
  (d) Combination surgeries – intramedullary nail with Ilizarov fixator.
(4) Amputation – very rare.

Joint salvaging surgeries

Preserving the patient's own joint with active range of motion is the most ideal goal that can be expected in aggressive and recurrent tumors. The ''extended curettage'' can be carefully chosen to treat early diagnosed aggressive tumors contained within the confines of the bone and respecting the articular cartilage.[12,14,16] Despite higher chances of recurrence, curettage often allows for a better functional result. The meticulousness at surgical technique is of paramount importance as any spillage of these aggressive tumors is almost certain to result in recurrences.[19,20] A number of surgical techniques combining the different advantages of bone grafts and bone cement are being increasingly tried. In Fig. 1 two aggressive tumors have been treated by aggressive curettage and use of autogenous fibula, iliac crest grafts and bone substitutes. In Fig. 2 yet another two similar aggressive giant cell tumors have been treated by a combination of autograft and bone cement. Here the possibility of deleterious effect of bone cement on the articular cartilage is nullified by packing the subchondral area with autografts and bone substitutes prior to cementation of the remaining cavity. All these promising surgical techniques aimed at salvaging patient's own knee are yet to prove their efficacy and their long-term results are awaited.

Joint preserving surgeries

A mobile artificial knee joint with active extension is now a reasonable goal for the patients who are willing to accept the activity restrictions that are mandatory after this reconstruction.

Custom megaendoprosthesis

Endoprosthetic reconstruction provides long-term function and is associated with its own complications. It provides advantages of predictable immediate stability that allows for quicker rehabilitation with early full weight bearing.[21–23] Improvements in implant materials have greatly increased the durability of modern endoprosthesis. However, all are associated with long-term complications as the patient is cured of the disease in GCT. Polyethylene

Figure 1. (a) and (b) An aggressive GCT of medial condyle of tibia with infiltration of the soft tissues and intact articular cartilage. (c) and (d) It has been treated with "extended curettage" and autografts from ipsilateral fibula and iliac crest. The fibula is expected to act like a strut preventing collapse of thin subchondral bone. (e) and (f) Another aggressive giant cell tumor of upper end of tibia. (g) and (h) Treated with aggressive curettage and a mixture of autografts with bone substitutes.

wear is still a limiting factor for articulating surfaces, but the inserts are easily replaceable. However, fatigue fracture at the base of the intramedullary stem where it attaches to the body of the prosthesis is more problematic. In this location extraction of the remaining stem can be extremely difficult.

Segmental bone and joint prostheses usually are secured through composite fixation. By this method, an intrameduallary stem is fixed with cement while the shoulder region of the prosthesis is constructed with a porous coating with the goal of promoting late extramedullary cortical bridging. Initial fixation with cement provides immediate stability for quick rehabilitation. The purpose of extramedullary cortical bridging is to serve as a purse string to protect the cement–bone interface from particulate debris generated at the articulating surface and to provide additional support protecting the junction of the base of the stem with the body of the prosthesis. This area is otherwise susceptible to fatigue fracture as a result of stress concentration.[24]

Giant cell tumors pose few of the peculiar clinical differences compared to other tumors with respect to joint preservation. They occur in younger people with longer life expectancy. The reconstructed joint should be strong enough to withstand the heavy expectations of the patient over a longer period of time. There is no need for adjuvant or neo-adjuvant therapies. However, the prosthesis has to be tailored to suit the demands after wide excision of the tumor and thus is expensive. The best of the available prosthesis too are constrained to a large extent and have increased incidence of osteolysis, loosening and peri-prosthetic fractures. The presence of aggressive tumor, recurrent tumor, associated pathological fractures, or soft tissue infiltration in addition may preclude wide resection of the tumor in an attempt to joint preservation and lead to local recurrences.

Osteoarticular allograft transplantation

This has been very sparingly used in the management of GCT. However, it offers several attractive advantages including the ability to replace ligaments, tendons, and intra-articular structures. Several authors have reported success with this method of reconstruction in many pediatric skeletal malignancies, however, other authors have reported high rate of complications including nonunion at the graft–host junction, fatigue fracture, articular collapse, dislocation, degenerative joint disease, and failure of ligament and tendon attachments.[25–29]

Allograft–prosthesis composite

Allograft–prosthesis composites are an alternative providing long-term solution for some patients. They avoid the complications of degenerative joint disease and articular collapse while still preserving the ability to directly attach soft tissue structures such as the patellar tendon. But the high incidence of complications such as fatigue fracture, nonunion at the graft–host junction, deformity, and infection makes the outcome unpredictable.[30,31] Most

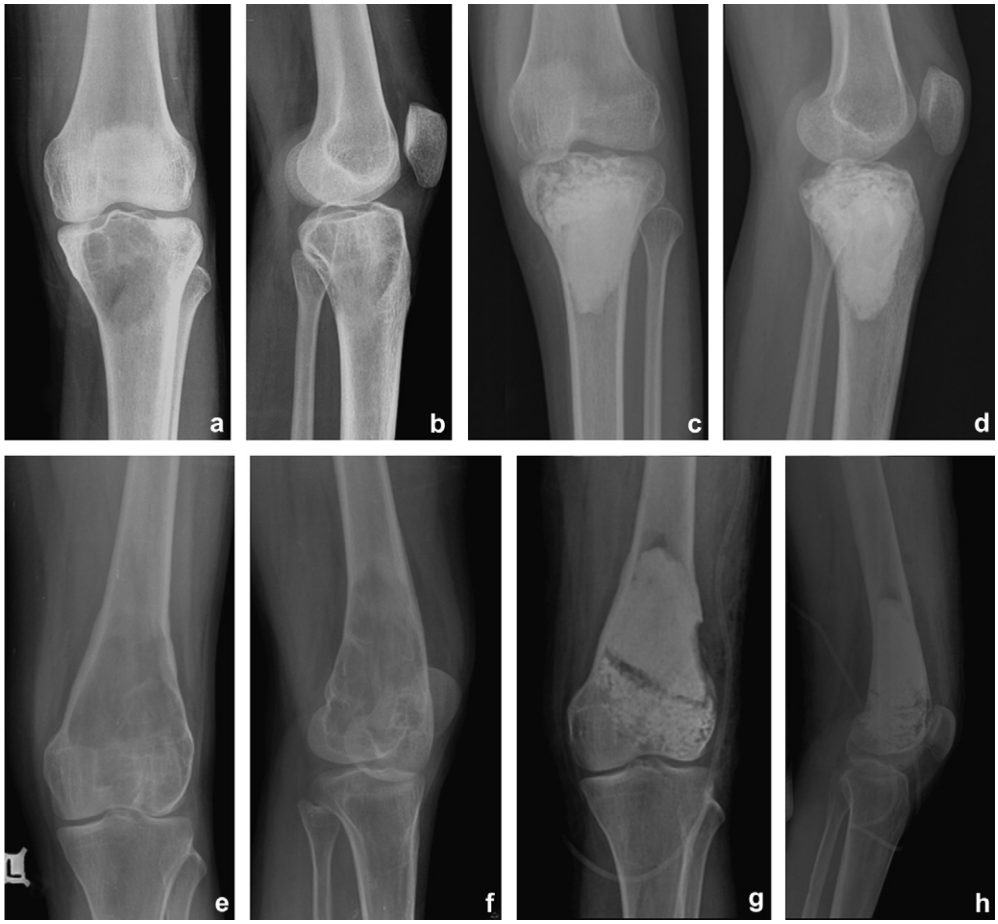

Figure 2. (a) and (b) Aggressive central GCT of upper end of tibia with thinned out subchondral bone and intact articular cartilage. (c) and (d) After thorough curettage, the subchondral area is tightly packed with iliac crest autograft mixed with bone substitutes prior to cementation of the remaining cavity. This may possibly minimize the thermal necrosis of the articular cartilage. (e) and (f) Another aggressive central GCT of the lower end of the femur with intact articular cartilage and thinned subchondral bone. (g) and (h) It was also treated similarly by combining the advantages of autografts, bone substitutes and bone cement after meticulous curettage.

surgeons commonly use this technique for an inadequate length of host bone to cement an endoprosthesis securely.

Joint sacrificing surgeries

Arthrodesis is a reasonable option in a young person who wishes to perform heavy labor.[24] For some patients arthrodesis is the better option considering their age, desired level of activity, and the extent of resection of bone or soft tissue which make arthroplasty difficult. It offers potential advantage of stable, durable, and predictable reconstruction that enables unrestricted activity but at the expense of losing motion of the knee.[32] In the developing and underdeveloped countries the reduced cost makes it an attractive option to the patient over expensive joint preservation options. Once the decision has been made to perform an arthrodesis, the technique selected should be associated with a high rate of success and few complications. The challenge to provide long-lasting survival and function of the limb after reconstruction is now being met with biological solutions using living bone. Resection arthrodesis of the knee is an extensive operation requiring prolonged recovery and is best reserved for vigorous young adults.

Intercalary bone grafting

Although an attractive option, the use of bone grafting alone has the drawback of potential graft fracture in these younger individuals with high expectations from surgery. The need for an enormous amount of graft to span a large bone defect after wide excision is technically difficult and is invariably associated with significant donor site complications. Several authors have reported on the technique of resection arthrodesis and reconstruction using various combinations of autogenous grafts from the fibula, tibia, or iliac crest.[33] In these studies up to 40% rate of nononcological complications has been reported. The complications have included nonunion, fatigue fracture of the graft, loss of fixation, and inadequate soft tissue coverage.

Tumor graft has been used after treatment with cryotherapy by some authors to fill the bone defect.[34] However, the efficacy of the graft with respect to its osteogenic capacity is questionable. These problems, along with the limited availability of autogenous bone, have led to experimental investigation with the use of allografts for arthrodesis either alone or in combination with autogenous bone grafts.[35–41] The deep-freezing or freeze drying of the allograft in an attempt to make it nonimmunogenic reduces the strength of the graft further. The results of vascularised bone transfer are more favorable but there are limitations in biomechanical strength, length, and availability.[42,43] The surgical technique too is highly demanding and needs expertise.

Intramedullary nail and bone grafting

Addition of an intramedullary nail will enhance the stability of these grafts and prevent problems with the strength of the graft. Any one of the aforementioned types of bone grafts can be safely used in conjunction with the intramedullary nail.[44,45]

Enneking and Sherley Turngraft procedure[24,33] is a method of resection arthrodesis using a specifically designed fluted medullary rod curved in its proximal half (radius of curvature, 125–175 cm) to fit the anterior bow of the femur. Turngraft is a technique by which the defect around the knee is bridged by a hemi-cortical bone graft of adequate length harvested from the anterior metaphyseo-diaphysis of either tibia or femur. The graft is turned by 180° and fixed across the defect with supplementary skeletal fixation, usually a long IM nail. If the joint is not breached by the tumor, patella is also used as an additional graft. The ipsilateral fibula has been classically used as posterior strut graft.

Distraction histogenesis

The Ilizarov method is widely used for reconstruction of the tibial shaft in the treatment of fractures, nonunion, traumatic bone defects, osteomyelitis and deformity, but there are very few reports of its use in the management of bone tumors.[46–49] Here, it has been employed in the reconstruction of defects after excision of tumors and for arthrodesis after joint resection. The living bone regenerated in distraction osteogenesis will eventually provide sufficient biomechanical strength, length, and durability.[50–53] Although external fixation may be prolonged, reconstruction by distraction osteogenesis results in a stable leg which avoids complications associated with prosthetic or allograft replacement and provides attachment for ligaments, tendons, and muscles.

Tsuchiya et al. in 1996[52] had reported their results after Ilizarov distraction osteogenesis of sub-articular bone gap following resection of giant cell tumors in the proximal tibia in five patients. They performed bone grafting at the docking site soon after positioning the bone fragments. The mean length of bone gap in their patients was 5.7 cm and the mean duration of external fixation was 233 days.

Combination surgeries

Tsuchiya et al. in 1997[53] reported their results of limb salvage after distraction osteogenesis in 19 patients of whom 10 had bone transport, three had shortening distraction, and six had distraction osteogenesis over an interlocked intramedullary nail. The mean length of defect was 8.4 cm and the mean external fixator index was significantly lower in the distraction histogenesis than that of intramedullary nail group of patients. Only five of their patients in the bone transport group had giant cell tumors.

We have used distraction osteogenesis over an intramedullary nail from 1996 to reconstruct defects and achieve sound knee arthrodesis following resection of aggressive and recurrent juxta-articular GCT.[54] This procedure was cost effective and effective in achieving the desired goals of reconstruction with least complications in selected patients with specific indications. Surgery was performed in three stages (Fig. 3).

Operative technique[54]

Stage 1. The primary procedure was directed towards *en block* resection of the tumor and stabilization of the limb together with maintenance of limb length (1–2 cm shorter than the normal limb for knee arthrodesis) using a small diameter interlocking intramedullary nail crossing the joint. The fibula was resected primarily in few of our initial cases in order to facilitate smooth bone transport. Later this was substituted by the dislocation of the superior tibiofibular joint.

The addition of an interlocking intramedullary nail is beneficial as a temporary measure to maintain the limb length. All the knee arthrodesis patients had 1–2 cm shortening post-operatively in order to facilitate ground

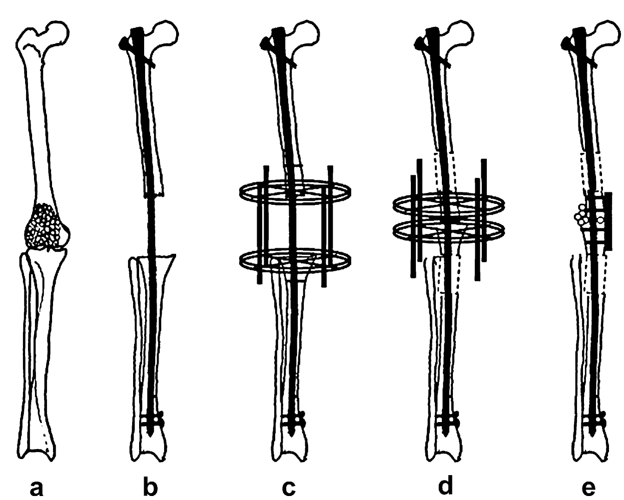

Figure 3. Diagrammatic representation of the operative steps of resection arthrodesis using combination device. (a) Aggressive or recurrent GCT of lower end of femur. (b) Wide excision of the tumor with maintenance of the limb length using thin-diameter long interlocked intramedullary nail. (c) Once the wound heals, double corticotomy and two-ring Ilizarov fixator is applied. Distraction is started after 7–10 days at a rate of 1 mm/day in 2–4 installments. (d) Diagram depicting the end point of bifocal distraction with two transported bone fragments coming in contact. (e) Immediate Ilizarov removal, plate osteosynthesis and bone grafting even before consolidation of the regenerate.

clearance while walking. A thin, stress-resistant intramedullary nail is appropriate for combined use to preserve the intramedullary blood supply and allow space for the insertion of wires. The interlocked intramedullary nail affords better axial and rotational control of the bone fragments during bone transport even with the use of two Ilizarov rings. The direction of transport is guided by the nail and this prevents mal-alignment.

Stage 2. Once the wound healed, a simple 2-ring Ilizarov construct was applied along with two level percutaneous corticotomies. Bifocal distraction over the nail was begun approximately 7–10 days after the second operation at a rate of 0.5 mm twice daily or 0.25 mm four times daily at each of the distraction sites. In bifocal distraction, the bone transport was attempted at the rate of 2 mm/day by moving both the rings by 1 mm towards each other. The distraction at the corticotomy site was confirmed by radiographs after 5 days of distraction. When callus formation was poor, distraction was delayed or compression and distraction of a moving segment (*Accordion maneuver*) was applied. Color Doppler study was done at regular intervals to monitor the blood flow in the regenerate in seven cases wherein the quality of the regenerate was doubtful. When the regenerate was consolidating prematurely the distraction rate was increased to 1.5 mm/day. The patients were allowed toe-touch weight bearing crutch walking as early as the pain subsided. The patients were discharged once they were confident of distraction by themselves. This distraction was then continued till docking of both the fragments.

With the use of bifocal distraction aiming to achieve trifocal osteosynthesis, the distraction rate nearly doubled. Immediately after the distraction was completed, the fixator was removed thus reducing the fixator time drastically. Keeping the number of rings to a minimum and the fixator time to the least possible, it was encouraging to see that only one of our patients had significant deep pin tract infection. Although the speed of distraction was the same at both the corticotomy sites, the shorter fragment moved faster than the longer fragment.

Stage 3. Once the bone fragments were docked, Ilizarov fixator was removed and plate osteosynthesis with autogenous ipsilateral iliac crest cancellous bone grafting was performed at the docking site. Patients were followed up every 4 weeks with radiographs to assess the bone transport and quality of the regenerate. The complications encountered were identified at the earliest and treated aggressively. Full weight bearing was allowed only after the docking site had united in at least three of the four cortices with trabeculae crossing the bone ends.

The plate osteosynthesis with cancellous bone grafting ensures faster and definite union at the docking site. It has the advantage of achieving osteosynthesis even before consolidation of the regenerate which usually takes twice the time of distraction. This greatly reduces the fixator time to a minimum. After the plate osteosynthesis, even much before consolidation of the regenerate, the patient was allowed gradual progression to partial weight bearing walking with a single crutch. This early guarded weight bearing would probably help faster consolidation of the regenerate.

Results. Twenty-two patients with established diagnosis of recurrent giant cell tumor around the knee from 1996 to 2002 underwent resection arthrodesis using the described technique (Fig. 4). The total number of giant cell tumors of the knee treated during this time frame being 108, nearly 20% underwent resection arthrodesis. There were 16 males and six females. The mean operative age of the patients was 35.63 ± 7.03 years (24–52 years). Seven lesions were in the tibia and 15 in the femur. Nine cases underwent this procedure primarily for isolated stage 3 aggressive tumors after an incision biopsy or FNAC, six following pathological displaced intra-articular fracture, five for recurrence after primary surgery and two for soft tissue extension. Preoperatively all the patients had magnetic resonance imaging scan of the lesion as a part of surgical staging. All the patients who underwent the resection arthrodesis had stage 3 tumors. Two indices were used to evaluate the results: an *external fixation index* was obtained by dividing the entire

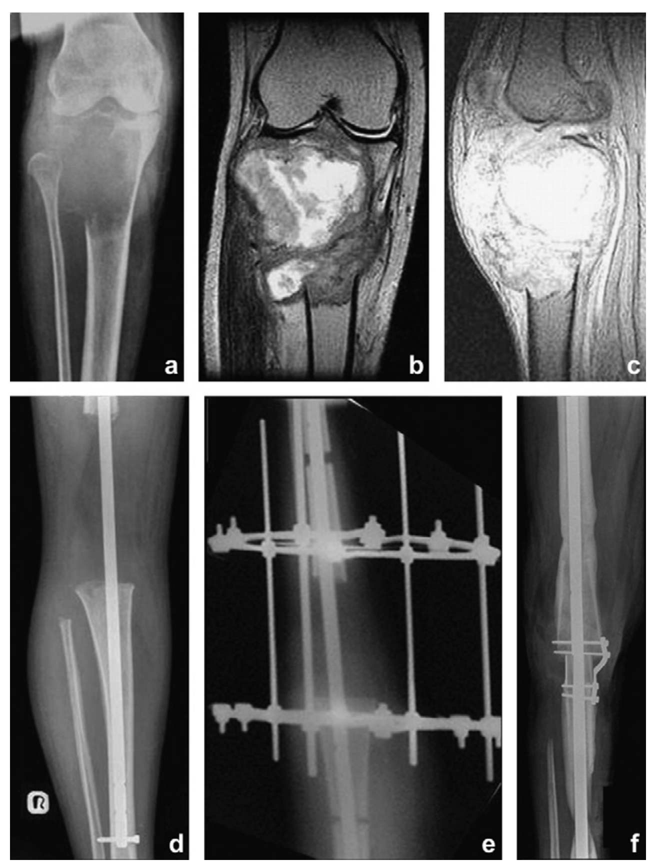

Figure 4. (a) An aggressive GCT of the upper end of tibia infiltrating the soft tissues. (b) and (c) MR images showing the extent of tumor and joint involvement in addition to soft tissue infiltration. (d) Bone gap of 12 cms after wide resection of the tumor and interlocked intramedullary nailing. (e) Bifocal distraction using two-ring Ilizarov construct. (f) End result following plating and bone grafting at the docking site with good union.

duration of external fixation by the length of bone regeneration. The *distraction index* was obtained by dividing the duration of distraction by the length of bone regeneration. The function of the affected limb was assessed at the final follow-up according to Enneking.[7]

The mean length of the bone defect was 12.34 ± 3.01 cm (range 7.7–18.6). The mean external fixator index was 7.44 ± 0.87 days/cm (range 6.1–9.8) and the distraction index was 7.88 ± 0.91 days/cm (range 6.3–10.3). Average delay in toe-touch crutch walking was 4.8 days (range 4–7), 4.9 months (range 4.6–5.8) for partial weight bearing with single crutch and 9.3 months (range 8.9–11.2) for unaided full weight bearing. The mean period of follow-up for the patients was 64.5 ± 13.82 months (range 48–94). The function of the affected limb was rated excellent in 10 and good and fair result in six patients each as per Enneking criteria. No local recurrence of tumor was seen. All patients were free from disease and none has metastases at the last follow-up.

Seven complications occurred in five patients, including two skin invaginations, two mild pes equinus, one deep infection, one premature consolidation of the regenerate, and one subluxation of the head of the fibula with transient foot drop. Skin invaginations were treated by resection of elongated and infolded skin and suturing the ends together at the time of docking. Pes equinus were managed by physiotherapy after removal of the Ilizarov apparatus. The only wire which had superficial infection went in for deep infection when bone transport was complete. It was treated by removal of the Ilizarov, irrigation, and intravenous antibiotics. The case of premature consolidation of regenerated bone was managed by a further percutaneous osteotomy, resulting in excellent bone regeneration. The patient with foot drop along with subluxation of the head of fibula was managed by stopping the distraction for 3 weeks while the neuropraxia recovered.

Amputation

Amputation is only of historical interest as the patients are diagnosed early and are aware of the better treatment alternatives available. Only indications are fungation of the tumor mass and multiple recurrences.

Future

Early definite recognition of aggressive tumor is the first step in prevention of tumor recurrence after surgery. A careful meticulous physical examination cannot be substituted by any investigation. It needs to be combined with radiography, CT/MRI scans, bone scans and FNAC to stage the disease. Lot of newer diagnostic modalities like DNA cytophotometry, proliferation index, gene expression of vascular endothelial growth factor (VEGF) and lymphocyte invitro response to GCT have been developed to determine the aggressiveness and to prognosticate the biological behaviour of the GCT.[55] But none seem to be definitive enough. There is a need for better method to understand these biological events so as to help the surgeon treat these tumors in a more rational way. When diagnosed, early aggressive intervention with careful meticulous surgical technique is the key factor reducing the risk of recurrences.

For tumors or recurrences infiltrating into the soft tissues sparing the articular cartilage, joint salvaging procedure (saves patients' own joint) preserving maximum disease free subchondral bone and articular cartilage followed by reconstruction of the bone defect should be attempted. More clinical studies need to be conducted addressing the different surgical techniques that possibly can be used in this particular situation.

Whereas in cases of joint infiltration due to recurrences or intra-articular pathological fractures in aggressive GCT, joint preservating surgeries (joint replacement) have to be preferred. Further research is needed focusing on development of less constrained endoprosthesis which are more durable, less expensive and surgeon friendly.

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