CASE REPORT

The Sandwich Technique in the Management of a Peri-articular Giant Cell Tumour of the Knee

D Clarke[1], D Nepaul[2], H Chindepalli[3], K Lawson[3]

ABSTRACT

Peri-articular giant cell tumours present a unique challenge to the orthopaedic surgeon due to their locally aggressive nature. Native joint-preserving options confer less morbidity in comparison to radical excision and reconstruction; however, recurrence rates tend to be higher. The use of polymethyl methacryllate (PMMA) decreases the recurrence rate, but it has potentially devastating effects on the articular cartilage. To safeguard against this, the use of an insulating layer between the PMMA and the articular cartilage may be utilized with the goal of protecting the latter and is referred to as the Sandwich technique.

Keywords: Giant cell tumour, Sandwich technique

La técnica del sándwich en el tratamiento de un tumor de células gigantes periarticulares de la rodilla

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RESUMEN

Los tumores de células gigantes periarticulares representan un desafío único al cirujano ortopédico debido a su naturaleza localmente agresiva. Las opciones de conservación de las articulaciones nativas confieren menos morbilidad en comparación con la supresión y reconstrucción radicales. Sin embargo, las tasas de recurrencia tienden a ser más altas. El uso de polimetilmetacrilato (PMMA) disminuye la tasa de recurrencia, pero tiene efectos potencialmente devastadores sobre el cartílago articular. Para protegerlo, el uso de una capa aislante entre el PMMA y el cartílago articular puede ser utilizarse con el objetivo de proteger este último, lo que se conoce como la técnica del sándwich.

Palabras clave: Tumor de células gigantes, técnica del sándwich

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INTRODUCTION

The vast majority of giant cell tumours (GCTs) of bone tend to be peri-articular, with the distal femur and the proximal tibia accounting for over 50% (1). The next most common location is the distal radius. The lesions are epimetaphyseal in geographic location and thus offer management challenges due to their close association with articular surfaces. There remains no consensus as it relates to the management of this pathology. Various treatment options have been employed, ranging from the joint-preserving option of intralesional curettage to the more radical procedure of *en bloc* excision. Joint-preserving options offer a better quality of life and are associated with less morbidity than radical excision (2). For this reason, most surgeons prefer this option, but recurrence rates tend to be higher (2). To decrease the recurrence rate, intralesional curettage is often combined with adjuncts to increase the kill zone *ie* extended curettage.

Polymethyl methacrylate (PMMA) is most often employed as an adjunct with intralesional curettage because it also provides structural support (3). However, when PMMA is used in closed proximity to articular cartilage, there is the risk of inadvertent damage to the articular cartilage (4). The Sandwich technique provides a method of safeguarding against this by providing an insulating layer between the PMMA and the articular cartilage (5).

CASE REPORT

An otherwise healthy 16-year-old male presented to the outpatient Department of Orthopaedic Surgery, Kingston Public Hospital, Jamaica, with a three-month history of insidious onset of pain in the left knee. The pain had worsened over the three weeks prior to presentation, causing him to seek medical attention. His pain was initially severe at nights but then worsened with ambulation. He had no constitutional symptoms nor did he have a history of trauma. Examination findings were only significant for a left knee effusion, a 20 degrees flexion contracture with a range of motion of 20–120 degrees. Plain radiographs of the left knee revealed an eccentrically located 5 x 5 cm lytic epimetaphyseal lesion to his proximal left tibia with absence of a surrounding rim of sclerosis and a narrow transition zone (Fig. 1).

Magnetic resonance imaging and computed tomography scan of the left knee were ordered. The latter revealed extensive infiltration to the subchondral area. No mineralization, cortical breaches nor periosteal reactions were visualized (Fig. 2). Magnetic resonance imaging revealed a well-defined mass with intermediate signal intensity on T1 and a mixture of intermediate and high signal intensity on T2 weighted images (Figs. 3, 4). A presumptive diagnosis of a GCT of bone was made. A biopsy of the lesion was undertaken which confirmed the presumptive diagnosis.

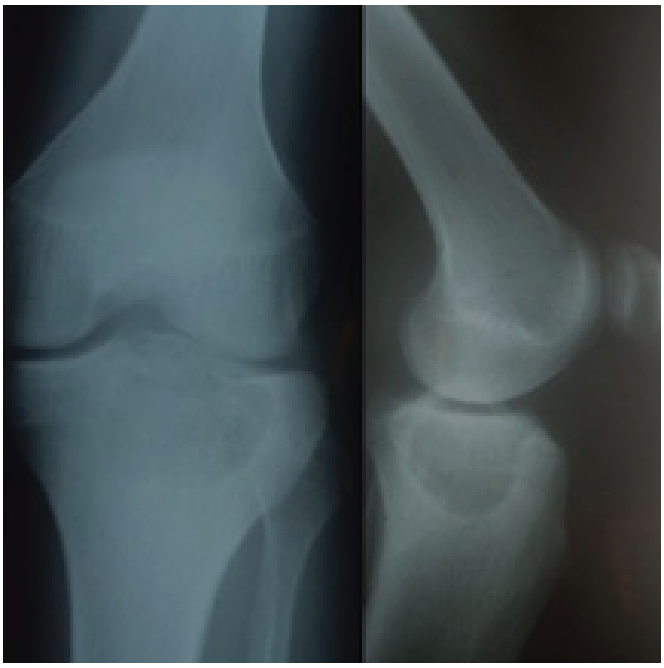

Fig. 1: Anterior posterior and lateral radiograph of the left knee showing eccentric lytic epimetaphyseal lesion.

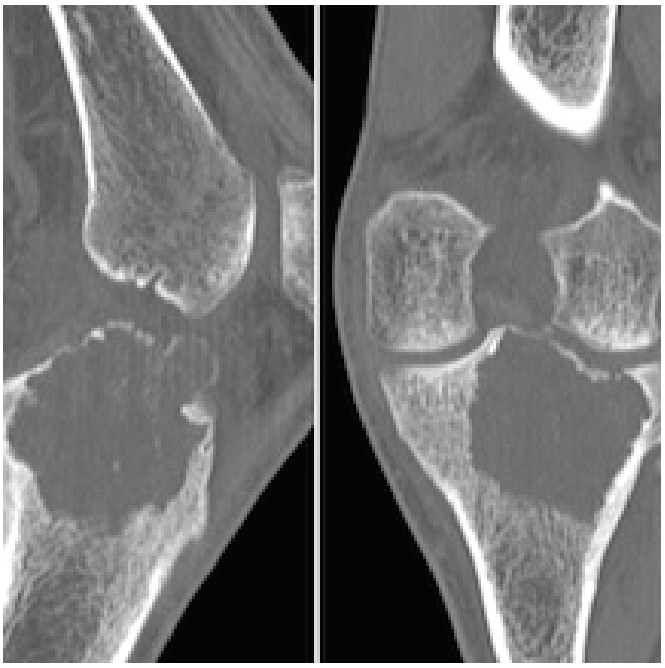

Fig. 2: Computed tomography images (sagittal and coronal views showing the subchondral extent of the tumour).

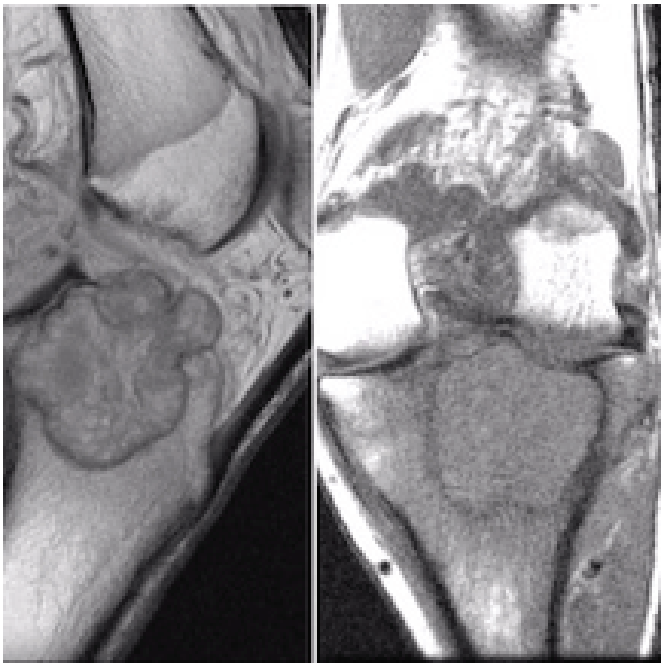

Fig. 3: T1 weighted magnetic resonance imaging, saggital and coronal views showing intermediate signal intensity of the tumour.

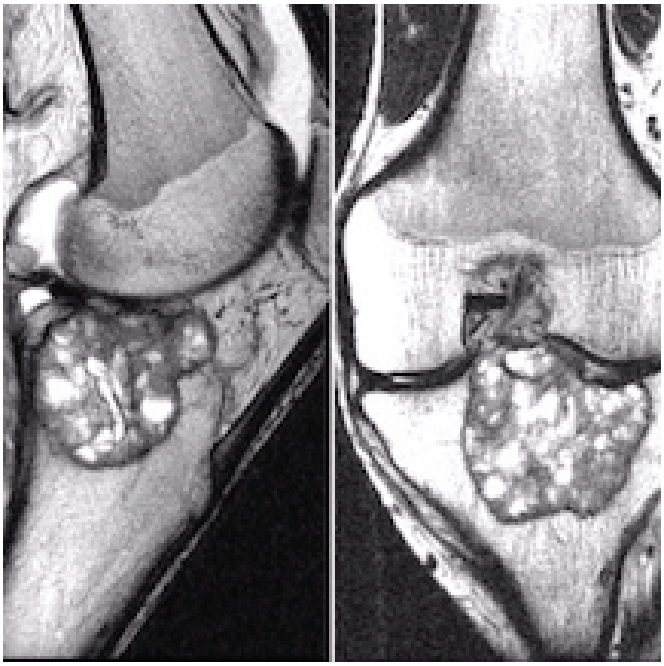

Fig. 4: T2 magnetic resonance imaging weighted images, sagittal and coronal showing mixture of intermediate and high signal intensity of lesion.

Definitive surgery was undertaken six weeks later utilizing the Sandwich technique. A bone window was created, and extended curettage with high-speed burr and PMMA applied for both its adjuvant property and structural support. An insulating area was then created using oxidized cellulose and subchondral cancellous allograft placed after the bone cement had completed polymerization. An L-Buttress plate was utilized laterally for stabilization (Fig. 5).

His postoperative period was uneventful. Chemoprophylaxis was instituted for a two-year duration in the form of alendronate. Immediate weight-bearing was allowed postoperatively. After three months, his extension lag and flexure contracture had resolved. At one year postoperatively, his radiographs revealed mild degenerative changes, but he reported no knee pain. At two years postoperatively, he continued to be asymptomatic. Radiographs done during that visit revealed incorporation of the subchondral bone with no evidence of recurrence (Fig. 6).

DISCUSSION

Giant cell tumours of bone were first described by Cooper and Travers in 1818, and the term was subsequently coined by Bloodgood in 1923 (6). They are also referred to as osteoclastomas, a terminology popularized by Schwajowicz. Osteoclastomas are most commonly seen in the third to fifth decades of life with a slight female predilection (1). They occur most commonly in the distal femur and proximal tibia, as in the index case, accounting for over 50% of cases (7). The distal radius is the next most common site, accounting for approximately 10% of cases (1).

A GCT is a locally aggressive tumour with the potential to metastasize to the lungs, which occurs in about 1–4 % of cases (7, 8). Histologically, it is characterized by the presence of neoplastic mononuclear stromal cells, mononuclear histiocytes and multinucleated giant cells (9). The giant cells are responsible for the osteolytic activity of the tumour through the action of Cathepsin K. These giant cells are recruited by the neoplastic mononuclear cells through the expression of nuclear factor kappa-B ligand (9).

The relatively early age of presentation, geographic epimetaphyseal location of these tumours and the osteolysis produced by the giant cells present unique challenges to the orthopaedic surgeon. In the management of a GCT of bone, the surgical decision is based on the risk of recurrence, the morbidity associated with extensive procedures, the feasibility and the effect of joint-preserving procedures on the articular surface (2). Management options range from joint-preserving option of curettage with or without adjuncts (*ie* extended curettage) to the more radical procedure of *en bloc* resection with reconstruction. Radiotherapy is another treatment option that is reserved for unresectable tumours. The utilization of systemic adjuvant therapy to decrease the recurrence rate has also been advocated ranging from bisphosphonates to targeted therapy.

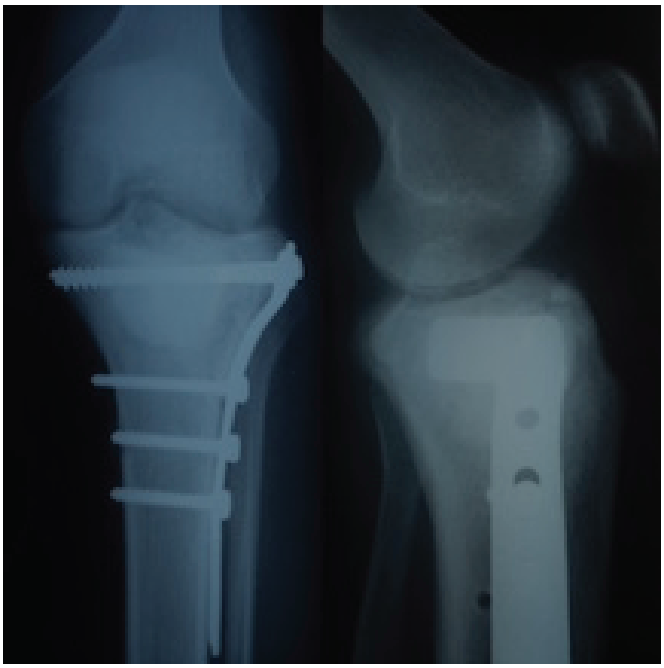

Fig. 5: Postoperative radiographs, anterior posterior and lateral views showing polymethyl methacryllate cementoma and subchondral grafting with buttress plate *in situ*.

Fig. 6: Anterior posterior and lateral radiographs two years postoperatively.

Curettage may be done in isolation or combined with adjuncts, with or without bone fillers. In their study, Hirn *et al* demonstrated that cavities less than 60 cm^3 in volume or 5 cm in diameter demonstrated satisfactory healing without bone fillers, whereas those greater than 5 cm were at an increased risk of pathological fractures (7). Curettage offers a joint-preserving option but tends to have a greater risk of local recurrence in comparison to *en bloc* resection (10). Earlier studies even suggested that there was an increased risk of local recurrence with curettage in the presence of a pathological fracture (11). However, this has not been confirmed by more recent studies (12–14). Recurrences are most common within the first two years post-curettage and are decreased by the utilization of adjuncts, *ie* extended curettage (15). Extended curettage combines the mechanical effect of curettage with a chemical adjunct to extend the kill zone.

The adjuncts include phenol, liquid nitrogen and bone cement/PMMA, which is the most widely used adjunct either in combination or in isolation. Polymethyl methacryllate is formed by an exothermic reaction and induces thermal tumour necrosis and also hypoxic tumour necrosis induced by its monomer (16). Balke *et al* showed that statistically the use of bone cement significantly decreased the recurrence rate by a factor of eight when compared to high-speed burring used in isolation (13). When compared to other bone fillers, it decreased the recurrence by over 50% (7).

Polymethyl methacryllate offers other benefits, such as providing a contrast on radiographs of the bone-cement interface, which allows for early detection of recurrence (17). When used as an adjunct, it also provides structural support and allows for immediate weight-bearing (3). Despite its benefits, there are still concerns and contrasting reports about the effect of bone cement when used in close proximity to the articular cartilage (18). In their 20-year retrospective study of 53 patients with a median follow-up of 86 months, Van der Heijden *et al* found a 17% radiographic incidence of Kellgren and Lawrence (KL) grade 3 or 4 osteoarthritis (19). However, the functional outcome and quality of life did not differ from those with KL grade 0–2. This represented an intermediate outcome study and required longer follow-up (19).

In their experimental study, Radev *et al* found that a minimum subchondral bone thickness of 2 mm was necessary to prevent articular damage induced by PMMA (20). To mitigate against the potential harmful effects of PMMA on the articular cartilage, the Sandwich technique may be employed. It involves the use of an insulating layer to protect against the thermal effect of PMMA and the addition of bone graft beneath the subchondral layer to improve bone stock. Thus, this facilitates the use of PMMA to achieve extended curettage by its thermal effect and hypoxic effect of its monomer while the articular cartilage degradation and subsequent sequelae are protected against.

In their review of 36 cases using the Sandwich technique, Saibaba *et al* reported a very low recurrence rate of 2.8% and a good functional outcome of 92.3% of their patients at a single institution (5). In their practice and utilization of the Sandwich technique, two adjuvants in the form of bone cement and phenol were utilized. Saibaba *et al* emphasized the importance of adequate exposure *via* a bone window and the importance of high-speed curettage and elimination of bony ridges. The importance of recognition and maintenance of the posterior periosteum to avoid spillage or escape of adjuvants and the potential complications were also highlighted. Unlike the index case, Saibaba *et al* did not use screw fixation because of the future hope of removing the PMMA and filling the defect with bone graft (5). In their prospective study of 26 patients with a GCT of the knee, Kundu *et al* found a recurrence rate of 8.3% and good functional outcome with a mean arc of motion between 123.52 ± 10.21 degrees (21). However, the mean follow-up was short, ranging from 2 to 6.5 years.

The Sandwich technique for management of the knee offers a joint-preserving option, allowing for the utilization of PMMA for both its adjuvant and structural property while attempting to mitigate the potential harmful effects of PMMA used in close proximity to the articular surface. The intermediate outcome follow-up has been promising, but long-term follow-up is required.

REFERENCES

1. Campanacci M, Baldini N, Boriani S, Sudanese A. Giant-cell tumor of bone. J Bone Joint Surg Am 1987; **69:** 106–14.
2. Fong YC, Chen TH, Chen WM, Lo WH. Giant-cell tumor of bone around the knee. Zhonghua Yi Xue Za Zhi (Taipei) 1997; **59:** 240–7.
3. Bini SA, Gill K, Johnston JO. Giant cell tumor of bone. Curettage and cement reconstruction. Clin Orthop Relat Res 1995; **Dec:** 245–50.
4. Turcotte RE, Wunder JS, Isler MH, Bell RS, Schachar N, Masri BA et al. Giant cell tumor of long bone: a Canadian Sarcoma Group study. Clin Orthop Relat Res 2002; **Apr:** 248–58.
5. Saibaba B, Chouhan DK, Kumar V, Dhillon MS, Rajoli SR. Curettage and reconstruction by the sandwich technique for giant cell tumours around the knee. J Orthop Surg (Hong Kong) 2014; **22:** 351–5.
6. Bloodgood JC. Benign giant-cell tumor of bone. Its diagnosis and conservative treatment. Am J Surg 1923; **37:** 105–16.
7. Hirn M, de Silva U, Sidharthan S, Grimer RJ, Abudu A, Tillman RM et al. Bone defects following curettage do not necessarily need augmentation. Acta orthopaedica 2009; **80:** 4–8.
8. Dominkus M, Ruggieri P, Bertoni F, Briccoli A, Picci P, Rocca M et al. Histologically verified lung metastases in benign giant cell tumours – 14 cases from a single institution. Int Orthop 2006; **30:** 499–504.
9. Werner M. Giant cell tumour of bone: morphological, biological and histogenetical aspects. Int Orthop 2006; **30:** 484–9.
10. Gitelis S, Mallin BA, Piasecki P, Turner F. Intralesional excision compared with en bloc resection for giant-cell tumors of bone. J Bone Joint Surg Am 1993; **75:** 1648–55.
11. O'Donnell RJ, Springfield DS, Motwani HK, Ready JE, Gebhardt MC, Mankin HJ. Recurrence of giant-cell tumors of the long bones after curettage and packing with cement. J Bone Joint Surg Am 1994; **76:** 1827–33.
12. Dreinhofer KE, Rydholm A, Bauer HC, Kreicbergs A. Giant-cell tumours with fracture at diagnosis: curettage and acrylic cementing in ten cases. J Bone Joint Surg Br 1995; **77:** 189–93.
13. Balke M, Schremper L, Gebert C, Ahrens H, Streitbuerger A, Koehler G et al. Giant cell tumor of bone: treatment and outcome of 214 cases. J Cancer Res Clin Oncol 2008; **134:** 969–78.
14. Becker WT, Dohle J, Bernd L, Braun A, Cserhati M, Enderle A et al. Local recurrence of giant cell tumor of bone after intralesional treatment with and without adjuvant therapy. J Bone Joint Surg Am 2008; **90:** 1060–7.
15. Kivioja AH, Blomqvist C, Hietaniemi K, Trovik C, Walloe A, Bauer HC et al. Cement is recommended in intralesional surgery of giant cell tumors: a Scandinavian Sarcoma Group study of 294 patients followed for a median time of 5 years. Acta Orthop 2008; **79:** 86–93.
16. Goodman HJ, Benevenia J. Adjuvant treatment of non-malignant active and aggressive bone tumors. Current Orthopaedic Practice 2009; **20:** 610–5.
17. Wada T, Kaya M, Nagoya S, Kawaguchi S, Isu K, Yamashita T et al. Complications associated with bone cementing for the treatment of giant cell tumors of bone. J Orthop Sci 2002; **7:** 194–8.
18. Nelson DA, Barker ME, Hamlin BH. Thermal effects of acrylic cementation at bone tumour sites. Int J Hyperthermia 1997; **13:** 287–306.
19. Van der Heijden L, Van de Sande MA, Heineken AC, Fiocco M, Nelissen RG, Dijkstra PD. Mid-term outcome after curettage with polymethylmethacrylate for giant cell tumor around the knee: higher risk of radiographic osteoarthritis? J Bone Joint Surg Am 2013; **95:** e159.
20. Radev BR, Kase JA, Askew MJ, Weiner SD. Potential for thermal damage to articular cartilage by PMMA reconstruction of a bone cavity following tumor excision: a finite element study. J Biomech 2009; **42:** 1120–6.
21. Kundu ZS, Gogna P, Singla R, Sangwan SS, Kamboj P, Goyal S. Joint salvage using sandwich technique for giant cell tumors around knee. J Knee Surg 2015; **28:** 157–64.