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The Use of Platelet-Rich Plasma with Autologous Bone Graft in Arthrodesis: A Salvage Procedure to correct the failure of a Keller Arthroplasty

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Sometimes the success of orthopedic and podiatric surgery may be compromised by inadequate bone repair. In recent years, new tools have been used to improve bone healing by accelerating the rate of bone formation and maturation of the matrix. For instance, there is currently great interest in the use of platelet gel to repair bone defects and accelerate the bone healing process. We report the case of a patient with recurrent hallux valgus following Keller resection arthroplasty for whom the problem was resolved with the use of an autologous cancellous bone graft enriched with platelet-rich plasma as a salvage procedure to enhance arthrodesis. The use of bone graft enriched with platelet-rich plasma (PRP) is a technology in the field of foot surgery should be investigated further.

Key words: Bone graft, Platelet- rich plasma, Keller arthroplasty, Salvage surgery

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The Keller-Brandes excision arthroplasty technique has been used for decades for the treatment of symptomatic hallux valgus and hallux rigidus. It is even today still sometimes considered a valid procedure for the management of painful adult hallux valgus associated with arthritis of the metatarsophalangeal joint.^{1,2} However, the technique often causes the patient dissatisfaction because it fails to maintain the proper alignment and biomechanical functionality of the hallux.

The most common complications associated with the procedure that have been reported in the literature include recurrence of the deformity, transfer metatarsalgia, excessive shortening of the toe, and "cock up" deformity.³⁻⁶ In most cases, the recurrence of the deformity is the result of poor correction of the inter-metatarsal angle after the procedure. Although the technique is out-dated today, it is still relatively common to find patients who have complications after undergoing a Keller arthroplasty. Salvage of the failed procedure by metatarsophalangeal joint arthrodesis (MTPJ-A) of the hallux is a complex surgical problem, especially if it results in shortening of the hallux.

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The use of bone graft enriched with platelet-rich plasma (PRP) is a relatively novel technology in the field of podiatric and orthopedic surgery. It is used to enhance bone formation and reduce the risk of delayed consolidation or non-union. The positive impact of PRP on bone healing is attributed to the angiogenic, proliferative, and differentiating effect on osteoblasts of the growth factors and tissue adhesion molecules it contains.⁷ The results of numerous studies that have used PRP associated with autologous or heterologous bone grafts show promise for achieving the regeneration of long bones and for the treatment of bone defects. Investigators have shown that PRP and its growth factors and cytokines enhance mesenchymal stem cell proliferation.^{8,9}

Case Report

A 61 year-old woman presented with painful hallux valgus of the left foot. According to her surgical history, in 1989 she had had an operation to correct hallux valgus of both feet by the Keller technique. In 1996, she had a revision on the left foot by means of re-excision arthroplasty and soft tissue reconstruction due of recurrence of the deformity. Our radiographic examination showed severe joint destruction in both feet with the result of asymptomatic hallux rigidus of the right foot, and hallux valgus of the left foot without significant shortening of the great toe. In both feet, there was broadening and flattening of the second and third metatarsal heads secondary to Freiberg's disease. (Fig. 1)

Surgery was planned for the left foot, consisting in MTPJ-A of the hallux. The procedure consisted of excision of the base of the proximal phalanx of the second toe, and metatarsal remodeling of the second metatarsal head with stabilization of the joint by means of a Kirschner wire. A cancellous bone graft was extracted from the base of the phalanx, second metatarsal head and first metatarsal head (bunion). This was triturated and mixed with 5 ml of PRP which was subsequently activated with 10% calcium chloride in accordance with the PRGF System® protocol (Biotechnology Institute, Vitoria, Spain).¹⁰ (Fig. 2)



Figure 1 Preoperative radiograph shows destruction of the first metatarsophalangeal joint in both feet. Recurrence of hallux valgus with hallux shortening of the left hallux can be observed.



Figure 2 Autologous bone graft triturated and mixed with activated PRP.

A flat osteotomy was performed on the first metatarsal head, and decortication and revascularization at the base of the hallux's proximal phalanx, with interposition of the graft that had been obtained, and stabilization by means of a 1.5 mm Kirschner wire (Fig. 3). Following surgery, the foot was immobilized in a short leg cast and the patient allowed walk aided by crutches. Progress postoperatively was normal until the fourth week with the onset of inflammation affecting the hallux accompanied by pain and increased local temperature compatible with an infectious process.



Figure 3 Immediate postoperative radiograph of the left foot show interposition of the bone graft with stabilization by Kirschner wire.

This forced the premature withdrawal of the Kirchner wire, and the initiation of antibiotic therapy for three weeks until remission of the clinical signs of infection. The foot remained immobilized in a short leg cast for 4 weeks.

After removal of the cast, the patient was placed in a reverse camber shoe for 4 weeks that elevates and protects the forefoot and allowed full weight bearing assisted by a crutch. Follow-up examinations with radiological control were conducted at 4, 8, 12, and 24 weeks, and one year postoperatively. The 12-week radiological examination showed the presence of lytic lesions at the level of the interphalangeal joint consistent with sequelae of osteoarthritic sepsis. (Fig. 4)



Figure 4 Twelve week anterior posterior radiograph demonstrating the resorption of graft with partial consolidation. Lytic lesions at the level of the interphalangeal joint by septic osteoarthritis can be observed.

Despite the early removal of the fixation, no delay was observed in consolidation of the bone in the zone of the graft. Instead there was steady progression to full fusion. (Fig. 5)

Discussion

Numerous salvage techniques have been described to resolve complications associated with the Keller-Brandes arthroplasty. These include arthrodesis, re-excision and reconstruction of soft tissue, and placement of hemi-implants or total implants.^{6,11} The existing evidence shows that MTPJ-A of the hallux is a good option for the restoration of the biomechanical integrity of the first ray after a Keller arthroplasty.¹²



Figure 5 One year postoperatively radiograph. Complete fusion and satisfactory alignment of the hallux has been attained.

A prospective study with long-term monitoring carried out sequentially on 28 feet which underwent an MTPJ-A following a failed Keller-Brandes arthroplasty found the procedure to be safe and effective, and to result in functional improvement with high patient satisfaction¹³

However, the technique is sometimes difficult to perform as a result of the resection arthroplasty drastically altering the anatomical configuration of the joint, producing a significant shortening of the hallux with the risk of non-union. In many cases, this circumstance requires the use of an autologous bicortical iliac crest graft combined with rigid fixation elements (low profile plates with cortical screws), thus increasing the technical difficulty of the procedure and its associated risk, as well as donor site morbidity.¹²⁻¹⁶

Although there are no conclusive data on the non-fusion rate following MTPJ-A as a salvage procedure after a failed Keller, according to the literature data, even with stable fixation systems the risk of non-fusion in patients who have undergone a hallux MTPJ-A with interposition of a bone graft as a salvage procedure is in the range 10%–24% compared to only 5%–8% in patients who have undergone the technique as the primary procedure.¹⁵⁻¹⁷ Some of these studies advise against re-fusion after a failed hallux MTPJ-A except for removal of the osteosynthesis material.¹⁸

New therapies have been used to increase the effectiveness of autologous grafts in bone regeneration for the treatment of bone defects, delayed consolidation, and non-fusion. Some studies have reported satisfactory results associated with the use of PRP for the treatment of bone defects. In the realm of orthopedic surgery, PRP has been used to improve osseous healing in fusion, fracture repair, and limb-lengthening procedures, and to accelerate soft-tissue healing in acute and chronic tendinous injuries.¹⁹⁻²¹ Similarly, good results have been reported with the use of PRP to treat recalcitrant nonunions of the lower limbs and in the treatment of post-traumatic spinal fusions.²²⁻²⁴ PRP has also been successfully employed in association with bone substitutes that have osteoconductive and osteoinductive properties to accelerate the healing process after tibial osteotomy in both animals and humans.^{25,26} Although recent studies seem to demonstrate the superiority of other preparations such as recombinant bone morphogenetic protein (rhBMP) associated with bone graft,²⁷ the recombinant production technique usually involves higher costs than the systems for obtaining autologous PRP.

In the present case, the association of PRP with autologous bone graft led to complete fusion in a bone of poor quality and without rigid fixation elements. Despite the early withdrawal of the Kirschner wire due to the appearance of infection in the interphalangeal joint of the hallux, there was no delay in consolidation, and complete radiological fusion was observed at 24 weeks.

Although the use of a graft obtained from the patient's own foot has already been reported in the literature as a salvage procedure following a failed Keller,²⁸ to the best of our knowledge, the present case is the first to use an autologous graft taken from the foot in association with a platelet gel as the salvage procedure.

According to the literature, the use in the technique of non-rigid osteosynthesis material such as Kirschner wires or Steinmann pins in association with the ankle brace surgical shoe is effective, even with immediate loading, and as in the present case, has the advantage of its easy removal in case of complication.^{12,29} Nonetheless, it has to be borne in mind that the use of intramedullary fixation elements can lead to increased risk of infection, ankylosis of the hallux's interphalangeal joint or breakage of the osteosynthesis material in patients who do not adequately comply with postoperative recommendations.

Conclusion

We consider that MTPJ-A with interposition of PRP-enriched autologous bone graft may be a useful alternative for the salvage of failures following Keller arthroplasty when there is no excessive shortening of the hallux. In particular, it can avoid the risks associated with the use of autologous bicortical bone graft and complex osteosynthesis material, with a concomitant reduction in donor site morbidity, better cosmetic results, and reduction in the costs associated with the use of complex osteosynthesis material. We consider that use of bone graft enriched with platelet-rich plasma (PRP) is a relatively novel technology in the field of foot surgery should be investigated further.

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