Biologic Approaches to Problems of the Hand and Wrist

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KEYWORDS

• Orthobiologics • Hand • Wrist • PRP • BMP • Kienböck disease

KEY POINTS

- Orthobiologics are not used as frequently in the hand and wrist as in other sites.
- The most frequently reported is the use of bone morphogenetic protein for the treatment of Kienböck disease.
- Animal studies have described improved tendon healing with the use of platelet-rich plasma (PRP), but no clinical studies have confirmed these results.
- PRP has been reported to produce improvements in the outcomes of distal radial fractures and osteoarthritis of the trapeziometacarpal in small numbers of patients.
- The use of orthobiologics in the hand and wrist has just begun to be explored, and the applications are promising, but clinical trials are necessary to establish efficacy and safety.

Although not as frequently used as in other sites, biologic solutions have been sought for a variety of orthopedic conditions in the hand and wrist, including Kienböck disease; scaphoid, distal radial, ulnar, and phalangeal fractures and nonunions; osteochondral lesions of the capitate; and thumb arthritis.

BONE MORPHOGENETIC PROTEIN

Kienböck Disease

Kienböck disease, first described in 1910 as "lunatomalacia," is osteonecrosis of the carpal lunate postulated to be caused by trauma with disruption of the blood supply to the lunate; however, no single cause has been identified and the exact mechanism of vascular impairment remains unclear. Other factors that may be involved in Kienböck disease include variations in skeletal development causing an irregular size or shape of the ulna, radius, or lunate, and medical conditions that affect blood supply, such as lupus, sickle cell anemia, and cerebral palsy. Progressive deterioration of the lunate causes pain and limits motion. When symptoms are unrelieved by nonoperative methods, operative treatment is indicated and may involve revascularization, joint leveling, proximal row carpectomy, or wrist fusion. Revascularization procedures are most commonly chosen for young, active patients for whom loss of wrist motion would be incapacitating and most often includes curettage of avascular bone from the lunate and placement of a vascularized bone graft. Bone morphogenetic proteins (BMP), both human (hBMP) and recombinant (rhBMP) forms, have been shown to induce bony healing in animal and human studies. BMPs have been successfully used in the treatment of open tibial fractures,[1] spinal fusions,[2] and nonunions.[3–5] Jones and colleagues[6] described improved range of motion, complete resolution of pain, and no further lunate collapse at 6 years after the use of hBMP with vascular pedicle implantation in a patient with stage IIIA Kienböck

The authors have nothing to disclose.
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Orthop Clin N Am ■ (2017) ■–■
http://dx.doi.org/10.1016/j.ocl.2017.03.010
0030-5898/17/

disease. Rajfer and colleagues[7] reported arthroscopic curettage and grafting with a mixture of autologous radial cancellous bone marrow graft and BMP-2 in 2 patients (3 wrists) with stage III Kienböck disease, all of which had favorable results. They suggested this technique of arthroscopic curettage, bone grafting, and adjunctive BMP as a minimally invasive alternative to radial osteotomy in patients who do not have pathologic ulnar-negative variance.

Fractures/Nonunions

Two studies of the use of BMP in the treatment of scaphoid nonunions reached opposing conclusions (Table 1). In one, Bilic and colleagues[8] randomly assigned 17 patients with scaphoid nonunions to treatment with autologous iliac graft, autologous iliac graft plus osteogenic protein (OP-1; Osigraft), or allogeneic iliac graft plus OP-1. At 2-year follow-up, they found that OP-1 improved the performance of both autologous and allogeneic bone implants. Computed tomography scanning and scintigraphy showed that sclerotic bone was replaced by well-vascularized bone in patients treated with OP-1. Radiographic healing time was reduced to 4 weeks in those with autologous grafts plus OP-1 compared with the groups with autologous iliac grafts alone. Patients with allogeneic grafts plus OP-1 had radiographic healing at 8 weeks, which was comparable to the healing time in patients with autologous graft alone. These investigators suggested that, because the addition of OP-1 to allogeneic bone produced clinical outcomes equal to those obtained with autologous graft, harvesting of autologous bone from the iliac crest might be avoided.

Contrary to these results, Rice and Lubahn[9] found that the addition of rhBMP-2 to surgical repair of 27 hand and wrist nonunions (phalanx, carpus, distal radius and ulna) resulted in radiographic union rates consistent with previously published rates and did not produce superior rates of union in their patients. Of 6 patients with scaphoid nonunions treated with rhBMP-2 by Brannan and colleagues,[10] 2 required scaphoid excision and midcarpal arthrodesis and 4 developed notable heterotopic ossification,

Table 1
Researched applications of BMP in hand surgery

Authors	Clinical Application	Purpose	Outcome
Jones et al,[6] 2008	Kienböck disease	Report a case of BMP used in combination with vascularized pedicle bone graft	Imaging demonstrated successful revascularization. Patient had resolution of pain and improved range of motion.
Rajfer et al,[7] 2013	Kienböck disease	Describe an arthroscopic technique to treat using autograft with BMP-2	Authors performed this technique in 2 patients (3 wrists) for stage IIIA and IIIB Kienböck disease with favorable results.
Bilic et al,[8] 2006	Scaphoid nonunion	Randomized trial comparing iliac bone graft with and without OP-1 (BMP-7)	OP-1 improved healing time of autograft. Healing time was similar for autograft and allograft with OP-1.
Rice & Lubahn,[9] 2013	Nonunions of hand/wrist	Compare radiographic union rates of historical controls with BMP in addition to surgical repair	The use of BMP-2 did not increase the radiographic union rate when used with surgical repair compared with surgery alone.
Brannan et al,[10] 2016	Revision scaphoid nonunion	To identify complications resulting from BMP use in a revision scaphoid nonunion ORIF	Use of BMP-2 was associated with higher complication rates than previously described. They include heterotopic ossification, persistent nonunion, and loss of ROM.

Abbreviations: BMP, bone morphogenetic protein; OP, osteogenic protein; ORIF, open reduction internal fixation; ROM, range of motion.