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CASE REPORT

Hand

Volar Plate Interposition Arthroplasty of the Proximal Interphalangeal Joint: A Novel, Modified Malerich's Technique

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Summary: The choice of prosthetic or autologous reconstruction for proximal interphalangeal (PIP) joint arthroplasty in degenerative osteoarthritis represents a challenge for hand surgeons, especially in consideration of complications and patient's quality of life. We report the case of a 49-year-old woman who developed diffuse arthritis of the finger joints, especially at the PIP joint of the third right finger. Radiographs showed destruction of the PIP joint, large osteophytes, marked narrowing of joint space, severe sclerosis, and deformation of bone contour. Through a volar approach, we removed the osteophytes, reshaped the joint, and performed an arthroplasty with volar plate interposition. The patient had an improved range of motion at 3 months postoperatively. This case study gives a detailed description and discussion, together with literature revision, of volar plate interposition arthroplasty to treat PIP osteoarthritis, as an alternative to other methods. *(Plast Reconstr Surg Glob Open 2022;10:e4541; doi: 10.1097/GOX.0000000000004541; Published online 28 September 2022.)*

INTRODUCTION

The Framingham offspring and community cohort study pointed out the age-standardized prevalence of radiographic osteoarthritis (OA) of the hand. Damage to the proximal interphalangeal (PIP) joint was found to be 13.5% (men) and 16.5% (women), while symptomatic PIP OA ranged from 0.7% to 2%.[1]

OA is considered a condition of the whole joint, rather than just the articular cartilage, and signs and symptoms can arise from the cartilage, underlying bone, synovium, muscles, tendons, ligaments, and entheses.[1] Symptoms commonly include pain, stiffness, and limitation or restriction of movement such as a decrease of grip and/or pinch strength. PIP arthrodesis remains the gold standard for treatment of PIP arthritis in patients with failed conservative management, including ultrasound, laser therapy, and anti-inflammatory medications.[2] Unfortunately, joint fusion and alternative prostheses produce significant postoperative complications.[3,4] As an alternative, an advancement PIP arthroplasty (PIPA) has been proposed to maintain or improve movement while reducing pain,[5] even if there are few reports in the literature discussing trends of PIPA utilization.

In this report, we describe indications and novel refinements of the original technique and propose a literature update.

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Received for publication January 7, 2022; accepted August 3, 2022.

DOI: 10.1097/GOX.0000000000004541

CASE REPORT

A 49-year-old female manual worker presented with diffuse arthritis of the finger joints, especially the PIP joint of the third right finger, complaining of chronic pain and severe stiffness, which she had for 5 years, with a significant worsening in the previous months. No previous trauma or positivity of rheumatologic tests was registered, and clinical tests showed no instability.

The third right finger PIP joint appeared fixed in a slight flexion (about 10 degrees), with advanced anatomical profile deformity and marked swelling. The active and passive range of motion (ROM) was nearly 0 degrees, with excruciating pain at passive mobilization (VAS score: 9).

An X-ray showed destruction of the third right finger PIP joint, large osteophytes, marked narrowing of joint

Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

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space, severe sclerosis, and deformation of bone contour (Fig. 1), placing the case on a Kellgren and Lawrence grade 4 OA.

Conservative treatment (ultrasound, laser therapy, and anti-inflammatory drugs) had been attempted previously without success.

Surgery was performed under axillary block with the aid of tourniquet control (250–300 mm Hg) and loupes magnification (4.2×) to achieve better pain control during and after surgery. Through a radially based Brunner type volar approach, the neurovascular bundles were both identified and protected, and the flexor tendon sheet exposed and opened obliquely in the area of the A3-pulley (Fig. 2). The volar plate was detached as distally as possible to preserve adequate length for advancement into the joint. On the ulnar and radial sides, the incision was prolonged to form a sleeve, including the partial release of the accessory collateral ligaments. Access to the joint was achieved by hyperextension. The osteophytes were removed through a volar approach from the lateral, medial, and dorsal aspects of the joint with a partial release of collateral ligaments under fluoroscopy control (Fig. 3).

After returning the PIP to a more anatomically correct shape, we inserted the proximal-based volar plate flap into the PIP joint, performing the interposition. The volar plate was adapted to cover the head of the first phalanx and did not need any distal fixation (Fig. 4). The entire head of the first phalanx was covered by the flap, almost 1 cm in length.

Intraoperative passive ROM was achieved completely.

Accurate hemostasis was performed, and the skin was closed with a 5-0 monofilament nonabsorbable suture. After surgery, the hand and wrist were immobilized in a bulky dressing with protective dorsal plaster splint. After 5 days, the splint was removed and a digital extension block splint in 20 degrees flexion was applied; passive and active motion was started with an extension block in 20 degrees flexion for 2 additional weeks and then progressed to allow full active ROM.

Three months postoperative, passive ROM was –5 degrees in extension and 65 degrees in flexion, and active ROM was –10 degrees in extension and 55 degrees in flexion. At 6-month follow-up, the operated joint showed excellent stability to manual stress applied in all directions, and passive and active ROM was –5 degrees in extension and 80 degrees in flexion; neither dislocation nor subluxation occurred, and visual analog scale (VAS) score was 0. (**See figures, Supplemental Digital Content**, in which a good functional result is documented at 6-month follow-up with ROM of –5 degrees in extension and 80 degrees in flexion, and VAS = 0, **http://links.lww.com/PRSGO/C163**.)

Fig. 1. Preoperative radiograph. Oblique view of the third right finger showing advanced PIP arthritis and bone deformity.

Fig. 2. Volar approach to the PIP joint: a sleeve of the flexor pulley system was formed starting at pulley A3, including the partial release of the accessory collateral ligaments; distal detachment of the volar plate (black arrow) and retraction of the flexor tendons (white arrow).

Fig. 3. Intraoperative fluoroscopy control: osteophyte removal (arrows) and reshaping of joint.

Fig. 4. Schematic drawing showing the technique of volar plate interposition arthroplasty; the volar plate adapts to the articular surface and is not fixed distally.

DISCUSSION

Surgical treatment of OA of finger joints should provide pain relief, range of motion preservation, and stability. Both arthrodesis and implants have been unable to fulfill these goals, often providing little improvement in pain relief, motion restoration, and stability.[4] Patients undergoing arthrodesis may develop infections, nonunion, malunion, hardware irritation, nail abnormalities, osteomyelitis, and paresthesia (Table 1).[3]

The most used implants (silicone spacer, metal–plastic implants, and surface replacement devices such as a pyrocarbon implant) have significant complication rates;[3] silicone with implant fracture; disruption of collateral ligaments; lateral instability; sclerosis around the implant; bony resorption and decreased ROM; metal-plastic showing high rate of removal, even if in a short-term follow-up; and pyrocarbon showing higher complication rates than silicone, including implant dislocation, subsidence, joints contractures, squeaky joints, and an increased rate of explantation (Table 1).[3]

Autologous microsurgical PIP transfer produces limited improvement in ROM and shows a high complication rate, often leading to secondary surgery. In adults, microvascular joint transfer is only indicated when fusion and arthroplasty are not appliable, and even in this case, only for PIP or metacarpophalangeal in young patients with high functional demands.[6]

The use of volar plate for arthroplasty was first reported for treatment of articular fractures of the PIP joint,[5] and a few reports[7,8] have pointed out the effectiveness of volar plate advancement arthroplasty for dorsal fracture-dislocation of the PIP joints when accurate joint congruity was not possible. The rationale for use of volar plate is that it can resist both compression and tension, as a robust fibrocartilage. Indications are stable joints free of infectious complications. The limitation of this method is the excision of both collateral ligaments. In 2002, Burton et al[9] published a preliminary report on the use of this technique for OA of PIP joint with encouraging results. Later, the original technique was modified preserving both collateral ligaments.[10] Unlike all these variants, we have neither sutured the volar plate to the dorsal capsule through bone tunnels, nor placed k-wire through PIP joints for 2–3 weeks, nor used pull-out wire or suture to secure the volar plate to the middle phalanx, but only let the volar plate fill the recipient bed, taking advantage of immobilization and spontaneous scarring. In this way, we avoided possible complications such as extensor injuries and/or adhesions, contractures, and stiffness, and started an early active and passive motion. We believe that the volar plate, as a stiff tissue, can slip into a small joint space with minor risk of displacement, as in the case reported.

Our variant of interposition arthroplasty could be a valid option in the treatment of PIP OA, as it can restore joint congruity by resurfacing the arthritic joint and provide pain relief and sufficient PIP joint mobility. Interestingly, by preserving the collateral ligaments, it can lead to durable stability in all planes, which instead can be a drawback of implant arthroplasty. Finally, the present study shows that volar plate interposition arthroplasty in OA could help in pain control and producing a better ROM (Table 1).

As far as pain control is concerned, joint denervation could also be considered, especially in the case of failure of procedures. We did not need to add denervation as pain control was good in our patient.

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Table 1. PIP Arthrodesis, Different Implants in PIP Arthroplasty, and PIP Volar Interposition Arthroplasty: Advantages/Disadvantages

	Pain Relief	Motion Restore	Infection	Malunion/ Nonunion	Pares-thesia	Revision and Explantation Rates	Implant Fracture	Loosening, Dislocation, Contracture, Squeaking, and Migration	Synovitis	Instability	Tendon Problems (Adhesions, Swan Neck)	Redo Surgery
PIP arthrodesis	–	– –	+	+	+	+	N/A	N/A	N/A	+	–	+
Silicone implants	+	+	+	N/A	–	+++	+	+	+++	++	– –	+++
Metal SRA Cemented implants	+	++	–	N/A	–	++	–	+	–	–	+	++
Metal SRA noncemented implants	+	++	–	N/A	–	++	–	++	–	–	–	++
Pyrocarbon implants	+	+	–	N/A	–	+++	–	+++	–	–	–	+++
PIPA	++	+++	–	N/A	–	–	N/A	N/A	–	–	–	–

N/A, not applicable

Data from the work by Srnec et al.[3]

ACKNOWLEDGMENTS

This article has been prepared conforming to the Helsinki Declaration. Each author (1) made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; (2) drafted the article and revised it critically for important intellectual content; (3) gave final approval of the version to be published; and (4) agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. They all met all four criteria for authorship according to the International Committee on Medical Journal Editors. None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this article.

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