SCIENTIFIC ARTICLE

Conventional Versus Computer-Assisted Corrective Osteotomy of the Forearm: a Retrospective Analysis of 56 Consecutive Cases

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Purpose Accuracy and feasibility of corrective osteotomies using 3-dimensional planning tools and patient-specific instrumentation has been reported by multiple authors with promising results. However, studies describing clinical outcomes following these procedures are rare. Therefore, the purpose of this study was to compare the results of computer-assisted corrective osteotomies of the diaphyseal and distal radius with a conventional non−computer-assisted technique regarding duration of surgery, consolidation of the osteotomy, and complications. Also, subjective and objective clinical outcome parameters were assessed.

Methods We retrospectively compared the results of 31 patients who underwent a corrective osteotomy performed conventionally with 25 patients treated with a computer-assisted method (CA) using patient-specific instrumentation. Baseline data were similar among both groups. The duration of surgery, bony consolidation, complications, gain in range of motion, and subjective outcome were recorded.

Results The mean operating time was significantly shorter in the CA group compared with the conventional group. After 12 weeks, significantly more osteotomies were considered healed in the CA group compared with the conventional group. Two patients in the CA group required revision surgery to treat nonunion of the osteotomy. Otherwise clinical results were similar among both groups.

Conclusions The results demonstrate that the computer-assisted method facilitates shorter operation times while providing similar clinical results. *(J Hand Surg Am. 2017;■(■):■−■.*

Type of study/level of evidence Therapeutic IV.

Key words Malunion, distal radius, patient specific instrumentation, rapid prototyping.

Malunion of distal radius or forearm fractures may lead to decreased range of motion, reduced grip strength, or painful instability of the distal radioulnar joint (DRUJ).[1,2] Several authors have reported that adequate realignment and accurate restoration of the normal anatomy is associated with an overall positive clinical outcome.[3−5] However, quantification of a complex

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multiplanar malunion and subsequent determination of the required correction by means of conventional radiographs or computed tomography (CT) images remain challenging.[6–8]

Recent advancements in computer-assisted 3-dimensional (3D) planning and 3D printing technology can support the surgeon in enabling a more accurate preoperative simulation combined with easy-to-use navigation aids so that the surgery can be performed as preoperatively planned. In the context of a malunion of the radius, computer-assisted corrective osteotomy has been described as a promising technique for accurate reconstruction if patient-specific guides are used.[9,10]

Although the accuracy of the reduction has been demonstrated, studies investigating clinical outcome parameters following these procedures are rare.[11]

MATERIALS AND METHODS

The aim of this study was to compare the results of computer-assisted corrective osteotomies of the diaphyseal and distal radius using 3D planning and patient-specific guides with a conventional, non–computer-assisted technique. We evaluated the duration of surgery, healing of the osteotomy, and complications. In addition, we assessed subjective and objective clinical outcomes.

Patient sample

After institutional review board approval was obtained, a convenience sample of 56 patients with symptomatic, posttraumatic deformities of the forearm treated with either a non–computer-assisted method (conventional group) or a computer-assisted corrective osteotomy[9] (CA group) was available for final analysis. The conventional group was treated between January 2003 and October 2008 and the CA group was treated between December 2009 and April 2015.

Patients with congenital deformities of the forearm and patients who underwent concomitant interventions during the index procedure (scapholunate ligament reconstruction or repair of the triangular fibrocartilage complex[12]) were excluded from final analysis. Thirty-one patients in the conventional group (15 males and 16 females; mean age, 31 y; range, 10–66 y) and 25 patients in the CA group (17 males and 8 females; mean age, 28 y; range, 11–71 y) were finally included.

Preoperative clinical and radiological assessment

Indications for surgical intervention were one or more of the following: painful instability of the DRUJ (n = 27, 15 patients in the conventional group, 12 in the CA group), reduced range of motion (ROM) (n = 27, 15 patients in the conventional group vs 12 in the CA group), ulnocarpal impaction syndrome (n = 11, 4 in patients in the conventional group vs 7 in the CA group) after nonoperatively or operatively treated extra-articular fracture of the distal radius (n = 40), diaphyseal radius fractures (n = 4), or both bone forearm fractures (n = 12).

Five fractures in the CA group and 4 fractures in the conventional group had previously been treated with open reduction and internal fixation.

Regarding the preoperative ROM, there were 8 patients with decreased pro-/supination and 2 patients with decreased flexion/extension alone in the conventional group and 7 patients with decreased pro-/supination and 3 patients with decreased flexion/extension alone in the CA group. A combination of decreased flexion/extension and pro-/supination was recorded in 6 patients in the conventional group and 3 patients in the CA group (Table 1). The analysis of clinical outcome parameters was performed after stratifying patients into the above-mentioned 3 groups of preoperative complaints.

Clinical assessment was performed by the surgeon and was therefore not blinded. Range of motion was assessed with a standard goniometer. We calculated the increase in ROM after surgery by subtracting the postoperative from the preoperative arc of ROM. A distinct cutoff value for reduced ROM, as an indication for surgery, was not set. The indication for operation was based on the patient's complaint. Instability was diagnosed by a clinical examination of increased translation of the distal ulna relative to the distal radius compared with the uninjured side. The indication for surgical intervention was pain on loading the unstable joint, provoking the instability pattern. Ulnar-sided wrist pain, exacerbated by ulnocarpal loading in combination with positive ulnar variance, was considered diagnostic for ulnocarpal impaction syndrome.

The subjective outcomes of patients operated because of painful instability of the DRUJ were classified as (1) persisting pain, (2) improved but remaining symptoms, and (3) complete resolution, respectively.

In addition to assessing self-reported parameters, a retrospective chart review was performed to determine hospital stay, duration of surgery, and bony consolidation. Regarding the duration of surgery, the tourniquet time was considered as an adequate surrogate.