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*ORIGINAL STUDY*

# Ulna-shortening osteotomy : subjective appreciation and long-term functional outcome

Alexandra CHERCHEL, Sophie VANDENDUNGEN, Jean-Pierre MOERMANS, Pascal LEDOUX

*From the Clinique du Parc Léopold, Brussels, Belgium*

**Ulna-shortening osteotomy is a therapeutic option for ulnar impaction syndrome. We aimed to assess the long-term subjective and functional outcome after ulna-shorteming osteotomy. We conducted a retrospective study of 18 patients presenting with ulnar impaction syndrome of various aetiologies, with an average follow-up of 5.9 ± 3.4 years. Seventeen patients (94.4%) were satisfied and would undergo the operation again. Although most patients reported residual complaints (83.3%) such as weakness (38%) or pain under given specific circumstances, objective measurements of wrist function were good. The average Mayo Wrist Score was 75.9 ± 13.4 (n = 16) and the average DASH score was 18.0 ± 13 (n = 12). Comparison of the operated and healthy limb did not show any significant difference in strength or range of motion, except for significantly reduced flexion on the operated side ($p < 0.05$). In this study, ulna-shortening osteotomy provided a good functional outcome and high subjective satisfaction over the long term.**

**Keywords** : ulnar impaction syndrome ; ulna-shortening osteotomy.

## INTRODUCTION

Ulnar impaction syndrome is the degenerative process which affects the ulnocarpal joint when it undergoes a chronic overload of compressive forces. Ulnar-positive variance increases ulnocarpal loading and is thus a risk factor for ulnar impaction syndrome. An ulnar-positive variance may be acquired from radial shortening after wrist fracture, physeal injury, or Essex-Lopresti injury. It may also be idiopathic, or present only during power grip, particularly when it is combined with forearm pronation (*7*).

The principle behind the treatment of ulnar impaction syndrome is ulno-carpal decompression. Frequently used surgical treatment alternatives for ulnar impaction syndrome are the wafer procedure and ulna-shortening osteotomy (*9*). The technique of ulna-shortening osteotomy was originally described by Milch in 1941 ; it then consisted in performing an oblique osteotomy fixated with a wire (*11*). The goal of the current study was to assess the long-term subjective and functional outcome after ulna-shortening osteotomy.

■ Alexandra Cherchel, MD, Plastic Surgery Resident. *Plastic Surgery Department, CHU Brugmann, Free University of Brussels, Belgium.*
■ Sophie Vandendungen, MD, Staff Orthopaedic Surgeon.
■ Jean-Pierre Moermans, MD, PhD, Professor and Staff Plastic Surgeon.
■ Pascal Ledoux, MD, Staff Orthopaedic Surgeon.
■ *Hand Surgery Center, Parc Léopold Clinic, Brussels, Belgium.*

Correspondence : Dr. Alexandra Cherchel, CHU Brugmann, Département de Chirurgie, Place A. Van Gehuchten, 4, 1020 Laeken, Belgium.
E-mail : alexandracherchel@hotmail.com


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## MATERIALS AND METHODS

Recruitment of patients was performed by entering the search term "ulna" in a patient database of the Clinique du Parc Léopold, covering the years 1998 to 2009. Forty seven patients whose operation label was «ulna-shortening osteotomy» were retrieved. We were able to obtain a consultation and clinical examination for 19 of those patients. One patient was excluded, as he is officially an invalid since the initial accident which caused a wrist fracture. Seven different surgeons operated on the patients selected for this study.

The initial medical history and operative data were gathered from the medical records. During the consultation, any information missing in the history was added, the patients underwent a clinical examination, and additional questions were asked. We sought to find out about the patients' subjective appreciation of the operation and whether they would go through the operation again. We inquired about any changes in sports or hobby performance and finally, we asked the patients to state any current complaints and answer with "yes" or "no" to the presence or absence of the following set of complaints : ulnar-sided wrist pain, clicking, wrist popping, weakness, stiffness or swelling. The clinical examination, in addition to inspection and palpation, included range of motion measurement and Jamar strength testing. The standardized outcome tests used were the DASH and the Mayo Wrist Score. Antero-posterior (AP) radiographs of the wrist were taken, as well as AP and lateral views of the forearm. Ulnar variance was then measured according to the technique of perpendiculars (*16*).

Statistical analysis was performed using the NCSS97™ software (Number Cruncher Statistical Systems, Kaysville, Utah). Strength testing and all range of motion measurements except pronation and supination were compared using Student's t-test. *P* values $< 0.05$ were considered statistically significant.

## RESULTS

The total population studied included 18 patients. Ten patients were male (55.6%) and eight were female (44.4%). The average age was 51.9 ± 14.5 years and the average age at surgery was 46.0 ± 14.1 years. In half of the patients, the operated hand was the dominant hand. The average follow-up duration was 5.9 ± 3.4 years.

In 77.8% of cases (14/18), the aetiology of the ulnar impaction syndrome was post-traumatic. The type of trauma included a fracture in 38.9% of cases (7/18), or did not involve any bony lesion in 33.3% of cases (6/18). In 4 patients (22.2%), the ulnar impaction syndrome was idiopathic, and in a single case, it was secondary to epiphysiodesis (5.6%).


***Fig. 1.*** — Preoperative wrist radiograph of a 48-year-old man showing a positive ulnar variance of 2 mm and immediate postoperative view.

In terms of prior surgeries aiming to treat ulnar-sided wrist pain, two patients in our series had undergone arthroscopy prior to the ulna-shortening osteotomy. In both cases, an arthroscopic shaving was performed, and in one of them, an arthroscopic wafer resection followed three months later. In addition, the patient who suffered a physeal damage had undergone radial distraction prior to the ulna-shortening osteotomy.

Fixation of the ulna osteotomy was with a plate and screws in 17 patients (94.4%) (Fig. 1), while an intramedullary nail was used in only one patient. Plate fixation was supplemented by a bone graft in 33.3% of cases (6/18) and by Chronos™ bone graft substitute in one patient (5.6%).

The average ulnar variance prior to operation was +3.6 ± 2.5 mm (n = 9). According to operation notes, the median resection length was 3 mm (range : 2-11 mm) (n = 18). The current average ulnar variance was -0.4 ± 2.1 mm (n = 18).

The only complication found in the series was delayed healing of the osteotomy in a patient with psoriatic arthritis, who was being treated with anti-TNF medication.

The fixation material was removed in 12 patients. This was done as a systematic measure in 4 patients ; in the others, the hardware was removed because of complaints consisting of various combinations of discomfort, pain and swelling.

When asked whether they would go through the operation again or not, 94.4% (17/18) of the patients said that they would. Only one patient said that he would not choose to be operated again. Although he presented no striking anomalies on clinical examination or on test scores (DASH score 5.6, Mayo Wrist Score 75), the patient complained of stiffness, reduced range of motion and inability to bear weight on a flat open hand, thus forcing him to rest on his fist instead.

In our series, only 3 patients had strictly no complaint regarding the operated limb (16.7%). Among the complaints currently reported by our patients, weakness was present in 7/18 patients, making it the most common complaint. It is noteworthy that in all of those patients, the aetiology of the ulnar impaction syndrome was traumatic, whether with or without fracture. Other types of complaints include scar pain, pain in a various circumstances, stiffness, swelling, and «popping» of the wrist (Table I).

Only 17 patients were submitted to clinical examination comparing Jamar strength testing and range of motion of the operated limb to that of the healthy limb. One patient was excluded due to severe contralateral limb pathology. The only parameter that was significantly different between both limbs was flexion ($p < 0.05$), which was limited in the affected limb (Table II).

Regarding pronation, only one patient presented with a pronation deficit of 20° compared to the contralateral wrist. Five patients out of 17 presented with a supination deficit (29.4%). The average supination in that subgroup was measured at 48 ± 29.5°. All those patients had post-traumatic ulnar impaction syndrome, and a supination deficit had been documented pre-operatively in three of them.

Table I. — Types of complaints reported by patients

| Complaint | n | % (n = 18) |
|---|---|---|
| Weakness | 7 | 38.9 |
| Pain (unspecified) | 4 | 22.2 |
| Pain upon leaning on hand | 4 | 22.2 |
| Stiffness | 4 | 22.2 |
| Decreased range of motion | 4 | 22.2 |
| Barometric pressure pain | 3 | 16.7 |
| Pain during specific activity | 2 | 11.1 |
| Scar pain | 2 | 11.1 |
| Swelling | 2 | 11.1 |
| «Popping» | 2 | 11.1 |

Of the 12 patients who have a particular sport or hobby, 41.7% were able to resume their activity of choice undisturbed. The others either had to adapt or refrain from engaging in their sport/hobby.

The average Mayo Wrist score was 75.9 ± 13.4 (n = 16). Two patients were excluded from this measurement due to contralateral pathology. The DASH score was available only for 12 patients. The two above mentioned patients were excluded, as were three other patients who answered less than the required 27 items on the test (*5*), and one patient who declined to take the test. While it was offered to her in her native language, she was not literate in that language and was thus unable to answer. The average DASH score was 18.0 ± 13.9. Where applicable, the optional DASH modules were calculated. The median sport/music DASH module score was 28.15 (range 0-100) (n = 8), and the median work DASH module score was 25.0 (range 0-68.8) (n = 11).

## DISCUSSION

This retrospective study involved a small number of patients. However, the average follow-up on our patients at 5.9 years is longer than in previous similar studies, in which it was between 18.5 months (*15*) and at best 51 months (*3*).

Ulna-shortening osteotomy for ulnar impaction syndrome has provided a high level of subjective satisfaction in a number of other studies. In the

Table II. — Comparison of strength and wrist range of motion between the operated limb and the healthy limb

| Parameter | Operated limb (average) | Healthy limb (average) | Difference |
|---|---|---|---|
| Grip strength (kg) | 31.4 ± 13.2 | 35.1 ± 16.0 | NS |
| Flexion (°) | 54.7 ± 14.4 | 65 ± 12.1 | $p < 0.05$ |
| Extension (°) | 62.4 ± 13.9 | 61.8 ± 13.3 | NS |
| Flexion-extension range (°) | 117.1 ± 24.6 | 126.8 ± 22.2 | NS |
| Radial inclination (°) | 20.3 ± 7.8 | 22.8 ± 6.8 | NS |
| Ulnar inclination (°) | 39.4 ± 12.1 | 40.6 ± 9.5 | NS |
| Inclination range (°) | 59.1 ± 14.1 | 62.6 ± 10.3 | NS |

study by Fricker *et al* on 26 patients with post-traumatic ulnar impaction syndrome, 23 patients stated that they were satisfied with the operation at an average follow-up of 21 months (*6*). Petersen *et al* studied a similar population composed of 16 patients followed for a median time of 18.5 months ; 13 patients would undergo the operation again and 75% of them experienced significant pain relief (*15*). In the population of Loh *et al*, a significant reduction in pain as assessed by a visual analogue scale was found at an average follow-up of 33.1 months (*10*). As our results demonstrate, this satisfaction appears to be maintained over time.

In spite of subjective improvement, we have found that most patients do have one or more complaints relative to the affected wrist. None of the complaints in our series have required further surgical management. However, some cases reported in the literature have required subsequent aggressive management such as a Sauvé-Kapandji procedure (*12*), a new osteotomy, or a wafer procedure (*15*). All corrections were indicated for persistent pain. Complaints otherwise related to the fixation material appear to be common (*10,12,15*).

We have found a single case of delayed union in our series of 18 patients. This complication is present in almost similar proportions in the series of Moermans *et al* (2/28 patients) (*12*) and Fricker (2/26 patients) (*6*), while the rate is higher in the series of Oskam (2/10 patients) (*14*). Other types of complications reported by multiple authors include non-union (*10,12,15*), reflex sympathetic dystrophy (*1,10*) and symptoms of damage to the dorsal ulnar nerve branch (*6,10,12,15*).

When considering the surgical history of our patients, it appears that we have made use of therapeutic arthroscopy in proportions similar to Chun and Palmer (*3*) and Fricker (*6*) but much less so than a number of other authors who performed a therapeutic arthroscopic action in at least half of their patients (*10,12,14,15*).

With an average DASH score of 18, we have a slightly better result than Moermans *et al,* whose final DASH score was 26 at an average follow-up time of 29 months. Nonetheless, the result in that series represents a statistically significant improvement on the preoperative DASH which the authors had measured at 40 (*12*). The score that we have obtained illustrates a good functional outcome which persists on the longer term.

The Gartland and Werley score has also been used by other authors to evaluate the outcome of ulna-shortening osteotomy. Their results have shown a significant postoperative improvement in subjective pain score, subjective and objective range of motion scores, strength score, and mean wrist score (*1,3*).

Significant improvement in the range of motion is also noted in the study by Moermans *et al* (*12*). The retrospective nature of our study did not allow us to gather sufficient data for extensive pre- and post-operative range of motion comparison. However, comparison between the operated and healthy limb has allowed us to see that both limbs are equally strong and mobile, except for flexion, which is significantly more limited on the operated side.

Constantine *et al* have compared ulna-shortening osteotomy and wafer resection in two groups of

11 patients each. Darrow's criteria yielded a subjective outcome which was rated excellent for 9 patients in the ulnar-shortening osteotomy group, and good for 8 patients in the wafer resection group. No significant difference was found in grip strength or range of motion analysis between the two groups. However, there were significant differences between the two populations in terms of age, follow-up, ulnar variance and resection length. The authors conclude that both methods can treat ulnar impaction syndrome successfully, however, they are cautious about stating that the techniques are interchangeable, due to the difference in ulnar variance (*4*).

Subjective satisfaction with the wafer resection is also high in other series of patients. Feldon *et al*, who initially described the procedure, has obtained 69% excellent results and 31% good results according to Darrow's criteria for his series of 12 patients (*5*). In a group of 11 patients, Nagle and Bernstein have obtained 64% excellent results using the same criteria, and 18% each of good, fair, and poor results (*13*). Tomaino and Shah's study yielded equally positive results with 23/26 patients being rated as completely satisfied based on a visual analogue scale. The other 3 patients presented persistent pain, one of them actually requiring revision to a distal ulnar resection (*17*).

Objective evaluations of the wafer resection are generally favourable. Grip strength appears to be maintained (*5,17*). In terms of range of motion, some studies report a maximum loss of range of motion of 10 degrees in any plane (*4,5*). Tomaino and Shah report preservation of forearm rotation and wrist flexion and extension in 64% and 68% of their patients, respectively ; they also report a maximum average loss of motion of 20° for pronation and 13° for supination. The authors specify that the residual range of motion was within the functional range for all patients at final follow-up.

Complaints reported by patients after a wafer procedure essentially consist of residual pain (*13,17*), usually in a small number of patients. A frequently reported complication is tendonitis, most particularly extensor carpi ulnaris tendonitis (*5,13, 17*). Other types of complications include an ulno-carpal scar requiring débridement, a dorsal wrist ganglion, and portal site erythema treated by antibiotics (*13*).

Our results are comparable to those of the wafer procedure in terms of subjective appreciation and objective outcome. We have reported a more varied set of residual complaints in our series than in the studies reviewed on wafer procedures (*13,17*). Residual pain appears to be present in a fairly greater proportion of our patients. The aforementioned studies have an average follow-up ranging between 27 and 32 months, which is somewhat less than half of our average follow-up.

The complications of ulnar-shortening osteotomy are directly related to the osteotomy in the form of non-union (*10,12,14*) or delayed union (*6,12,14*) as in our series, whereas the comlications of the wafer procedure tend to target surrounding tissues which are more subject to damage than those encountered during an ulnar-shortening osteotomy.

Proponents of the wafer resection cite the absence of hardware-related complications risk and the absence of bone union requirements as an advantage of the wafer osteotomy (*13,17*). While no bone healing or hardware removal is necessary for a wafer resection, the ulna-shortening osteotomy offers the advantage of minimally altering the wrist compartment by preserving the cartilaginous edge of the ulna. Barry and Macksound have proposed a cartilage-retaining open wafer resection technique. They present a retrospective study of 7 patients followed for an average of 30 months ; in 5 patients available for a longer follow-up, they report a good improvement on a visual analog scale pain score and preserved range of motion. They report one case of complex regional pain syndrome and one case of extensor carpi ulnaris tendonitis (*2*). This technique could potentially offer a compromise, reconciling the advantages of both techniques.

In conclusion, the high satisfaction rate and good functional outcome in our patient series suggest that ulna-shortening osteotomy is a valid therapeutic option several years after surgery. However, we recognize that this study has some weaknesses due to its retrospective nature. The preoperative data that could be gathered was scarce, and unfortunately, many patients were lost to follow-up so that only a small population of patients was available for analysis.

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