

# Temporary epiphysiodesis in adolescent patients with ulnocarpal impaction syndrome: a preliminary case series of seven wrists

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Adolescents with ulnar positive variance can develop ulnocarpal symptoms due to ulnocarpal impaction syndrome. Common treatment methods are conservative therapy, distal ulna epiphysiodesis or eventually ulnar shortening osteotomy. The aim of this preliminary case series was to investigate a recently described, new therapeutic approach using a reversible, temporary epiphysiodesis technique, following the principles of guided growth. Seven cases with the diagnosis of a painful ulnar positive variance, which underwent a temporary epiphysiodesis, were retrospectively evaluated. These cases consisted of four individual patients who received an intraoperatively customized plate fixation to slow down growth. The following parameters were collected: diagnosis, age at surgery, age at explantation, growth plate status at explantation, ulnar variance before and after surgery, complications and any clinical and radiological abnormalities. The radiological measurements of ulnar variance were performed according to the Gelbermann method. The seven investigated cases (average age at surgery 12.4 years; average age at explantation 14.7 years), in which a temporary epiphysiodesis was performed, showed an average ulnar variance of +3.9 mm (range: from +1.9 mm to

+6.1 mm) before the start of therapy. After explantation, an average ulnar variance of +0.1 mm (range: from -3.2 mm to +5.0 mm) was observed, which corresponds to an average reduction/improvement of -3.8 mm (range: from -0.5 mm to -9.3 mm). The ulnocarpal wrist complaints were significantly reduced after the intervention. One case needed a secondary ulnar shortening osteotomy. The described method of a temporary, reversible epiphysiodesis is an elegant, less invasive technique to correct the ulnar positive variance without irreversibly closing the growth plate. In case of therapy failure, a secondary ulna shortening osteotomy is still possible. *J Pediatr Orthop B* 30: 601–604 Copyright © 2020 The Author(s). Published by Wolters Kluwer Health, Inc.

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## Introduction

Children with ulnar positive variance, either congenital or due to post-traumatic changes, can develop an ulnocarpal impaction syndrome with ulnocarpal complaints and movement restrictions [1,2].

Cannata *et al.* reported in their study that 28% of the observed distal radius fractures resulted in different bone length in the forearm. However, this difference in length only caused symptoms if the difference in length was more than 1 cm [3]. A study by Tatebe *et al.* shows, however, that even slight malformations can cause symptoms [4]. In the literature, it is described that even with an ulnar excess length of 2.5 mm, the axial load is shifted to the ulna by 41.9% [5,6].

Common treatment methods are conservative therapy, epiphysiodesis or ulnar shortening osteotomy. According to Prommersberger *et al.*, surgery is indicated if a malformation is present, in which progression is to be expected, or if symptoms such as restricted mobility or ulnocarpal pain are present [7]. Epiphysiodesis of the ulna, however, is an irreversible intervention with results that cannot be predicted or planned with certainty. Studies on ulna shortening osteotomies after closure of the growth plate show good to very good results in the correction of the ulnar positive variance. However, such invasive procedures are associated with numerous risks, such as nerve lesions, delayed or no bone healing and irritation from osteosynthesis material [8–10]. Reports of ulnar shortening osteotomies with growth plates still open also show good results. There is a risk of over- or under-correction of the malposition and the need for further surgery later [11].

In the lower extremity, the ‘guided-growth’ concept with temporary epiphysiodesis is an attractive therapeutic option for correcting axial deformities during growth [12]. The aim

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of this study was to investigate a recently described, less invasive therapeutic approach with a temporary epiphysiodesis technique for overgrowth of the ulna [1].

**Methods**

Seven cases with the diagnosis of a painful, therapy-refractory ulnar positive variance, which had undergone a temporary epiphysiodesis, were retrospectively evaluated using chart review. These cases consisted of four individual patients who received a customized, shortened 1.0-mm thick nonlocking two- or three-hole plate (Stryker Leibinger GmbH & Co. KG; Freiburg, Germany; Fig. 1) with 2.3 mm screw size for growth stop [1]. The customized plates had a total length of up to 12 mm (if three holes used) while the screw lengths were 10–14 mm depending on the diameter of the ulna epiphysis (Fig. 1). The following parameters were collected: diagnosis, age at implantation, age at explantation, growth plate status at explantation, ulnar variance before and after surgery, complications and any clinical and/or radiological abnormalities. The radiological measurements of the ulnar variance were performed according to the Gelbermann method [13]. For the characterization of metric parameters, appropriate parameters such as arithmetic mean, minimum and maximum were determined. Therapy success was assessed by comparing the mean values of ulnar

variance before and after the procedure. No further statistical testing was performed due to the low sample size.

**Results**

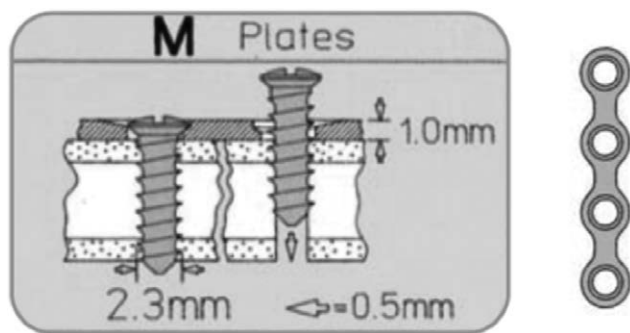
The seven investigated cases (average age at surgery 12.4 years; average age at explantation 14.7 years; Table 1) showed an average ulnar variance of +3.9 mm (range: from +1.9 mm to +6.1 mm) before the start of therapy. After explantation, an average ulnar variance of +0.1 mm (range: from -3.2 mm to +5.0 mm) was observed, which corresponds to a reduction/improvement of -3.8 mm (range: from -0.5 mm to -9.3 mm). The wrist symptoms of the patients were markedly reduced. In one case, a minor complication (dysesthesia of the hand dorso-ulnarly) occurred, while a second case eventually needed a secondary ulnar shortening due to insufficient correction at a relatively late age. In two cases, we observed a clinically irrelevant rotation of the plates used for epiphysiodesis during growth. In two cases, the growth plates were still open at the end of the therapy. No growth plate violations or axial deviations were seen.

**Discussion**

For the ulnocarpal impaction syndrome in children with positive ulnar variance, there are few conservative and surgical therapeutic approaches. In the seven cases examined with a mean ulnar variance of +3.9 mm, in which the technique of temporary epiphysiodesis was applied, satisfactory outcomes and radiological corrections were achieved. On average, there was a reduction of the overgrowth by -3.8 mm. At the end of the therapy, an average ulnar variance of 0.1 mm was present.

A study by Cha *et al.* from 2012 showed a similar result using a more invasive technique. Sixteen cases with an average age of 16.1 years and an ulnar variance of +3.4 mm on average, who underwent ulnar shortening osteotomy with residual ulnar growth still present, were examined. In this technique, the expected residual growth is estimated, and the shortening is adjusted accordingly. The ulnar variance after surgical correction and completion of growth was  $0.2 \pm 0.3$  mm [11]. This comparison shows that the correction potential of the much less invasive reversible temporary epiphysiodesis is equal to that of ulna shortening osteotomy; however, the same precision

Fig. 1



The implant, which is intraoperatively shortened to 2–3 holes, is shown (The illustrations are for illustrative purposes and are made with the kind support of Stryker GmbH & Co. KG.).

**Table 1 Detailed list of ulnar variance before and after temporary epiphysiodesis for each individual patient**

	Sex	Age implantation	Age explantation	Growth plate	Ulnar variance before (mm)	Ulnar variance after (mm)	Ulnar variance correction (mm)
Case 1	F	12	14	Closed	1.9	-2.7	-4.6
Case 2	F	12	14	Closed	2.4	-0.9	-3.3
Case 3	M	13	17	Closed	3.0	1.1	-1.9
Case 4	M	13	17	Closed	2.9	1.2	-1.7
Case 5	F	13	14	Closed	5.5	5.0	-0.5
Case 6	F	12	13	Open	5.6	0.0	-5.6
Case 7	M	12	14	Open	6.1	-3.2	-9.3
Mean		12.4	14.7		3.9	0.1	-3.8

F, female; M, male.

Fig. 2



(a) Preoperative anteroposterior radiograph showing positive ulnar variance. (b) Intraoperative anteroposterior radiograph showing the plate and the two screws *in situ*. (c) Ten days after surgery anteroposterior radiograph follow-up. (d) Latest image of the patient showing fully closed growth plates with perfect joint levelling.

of ulnar shortening as seen with an acute osteotomy is not possible with this procedure. Moreover, patients may have to wait for some weeks to few months to feel the desired pain relief. During this period, other concomitant factors such as activity modification, sports cessation or splints may help to decrease the initial pain level. In his article, however, Stevens mentioned the longer hospital stay, pain management and postoperative immobilization as some of the major disadvantages of an osteotomy. The risks associated with such an intervention and the economic impact, while being as effective as another procedure, should not be overlooked [12].

The concept of reversible, temporary epiphysiodesis is widely used in pediatric orthopaedics on the lower

extremity and has been able to prevent many corrective osteotomies in cases of axial deformities. In Stevens' study, 63 of 65 patients (97%) were able to correct lower limb malpositions without osteotomy [12]. In the present study, six of the seven (85%) cases could be corrected sufficiently, so that no follow-up surgery was necessary. The comparison also shows that with a concept adapted for the ulna as provided for our cases, the distal ulnar correction potential is sufficient to decrease length discrepancies in the upper as in the lower extremities. However, the surgical technique is delicate and thus a high level of precision is necessary to specifically avoid growth plate violations due to screw penetration or injury to the dorsal ulnar sensory nerve. Moreover, no adequate small-sized hardware material has been produced so far. Therefore,

we had to customize a thin 1.0 mm plate to the appropriate length desired.

Our described technique has its main advantage in young adolescents (10–13 years) with subtle to moderate differences in ulnar variance (e.g. 2–3 mm) and an open distal radius physis where it would be too risky to perform a permanent epiphysiodesis. Moreover, with our technique, it is possible to stop the ulnar growth until the radius length has equaled the ulnar length, and then the plate is explanted to allow for continued ulna growth. For this reason, the distal radius physis must be open and intact. Therefore, our technique is reversible and more predictable than a classic permanent epiphysiodesis. However, the required second surgery to remove the implant is a considerable disadvantage compared to the permanent epiphysiodesis.

In one of the seven cases, dysesthesia occurred in the dorso-ulnar side of the wrist, which decreased over the course of time, but did not completely resolve. Another case showed a very small correction, which can be explained by too little residual growth of the growth plate at the beginning of therapy. Eventually, an ulna shortening osteotomy had to be performed to correct the positive variance. In all other cases, there was sufficient correction of the positive ulnar variance. Based on this observation, a timely start of therapy seems to be essential for the success of the procedure. To avoid any revision surgery, thorough calculation of the estimated remaining growth based on bone age assessment should be pursued beforehand. The correct timing can then be calculated based on published growth charts of the distal ulna [14–16]. In general, temporary epiphysiodesis can be recommended when there is pain nonresponsive to physical therapy and/or a bone marrow edema in the lunate/triquetrum indicating active ulnocarpal impaction syndrome. However, our technique can also be considered in cases with larger positive variances (e.g. +5 mm or more) where you expect pain in the near future. The final ulnar variance aimed for should be neutral or slightly negative (Fig. 2). If this has been achieved, the plate is being explanted.

We acknowledge the following limitations. Due to the small number of cases investigated in this study, it is difficult to make definitive statements about the risks and side effects of this new technique. However, effectiveness has still be proven in this preliminary series.

To conclude, the method of a temporary epiphysiodesis with a commercially available system is an elegant and effective technique to correct positive ulnar variance, and less invasive than an ulnar shortening osteotomy. As shown in our cases with still open growth plates after

plate removal, it does not irreversibly affect the growth plate. The patients showed a high degree of satisfaction with the procedure. In case of therapy failure, a secondary ulna shortening osteotomy is still feasible.

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Study was performed at the Orthopaedic Hospital Speising, Vienna, Austria.

## Conflicts of interest

Dr. Ganger reports personal fees from Smith & Nephew Inc. (Memphis, TN) and personal fees from NuVasive Inc. (San Diego, CA) outside the submitted work. Dr. Farr reports personal fees from Orthofix Srl. (Bussolengo, Italy) outside the submitted work. There are no conflicts of interest for the remaining author.

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