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# Postoperative treatment of metacarpal fractures—Classical physical therapy compared with a home exercise program

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ABSTRACT

*Study Design:* Prospective cohort randomized controlled trial.
*Purpose of the Study:* Is either a home exercise (HE) program or traditional physical therapy (PT) more effective in the postoperative management of metacarpal fractures?
*Methods:* Sixty patients suffering from nonthumb metacarpal fractures who received mobilization-stable open reduction and internal fixation were included. All patients were prospectively randomized into either the PT group or the HE group. Follow-up examinations at 2, 6 and 12 weeks postoperatively.
*Results:* After 2 weeks, the range of motion (ROM) in both groups was still severely reduced. Twelve weeks after surgery the ROM improved to 245° (PT) and 256° (HE). Grip strength after 6 weeks was 68% (PT) and 71% (HE) when compared to the non-injured hand, improving to 91% (PT) and 93% (HE) after 12 weeks.
*Conclusion:* Study results show that both HE program and traditional PT are effective in the postoperative management of metacarpal fractures.
*Level of Evidence:* II.



## Introduction

Hand fractures are very common,[1] with metacarpals making up one third of those fractures.[2] Mainly young adults suffer from metacarpal fractures, and the subsequent incapacity to work has a socioeconomic relevance. Considering this fact, there is a strong interest in quick rehabilitation of hand function after surgical treatment of these injuries.

When looking at displaced shaft fractures, research has focused on the different methods of fracture fixation over the last years. It became evident that the surgical method had no relevant influence on the functional outcome or patient satisfaction.[3-5] It is crucial although that fracture fixation provides stable conditions to allow early functional treatment to prevent scar tissue adhesions and limited movement.[6,7] Postoperative treatment in Germany is usually performed by a physical therapist, although instructing the patient to autonomously exercise is becoming more and more important. At this time, there are no suggestions from professional organizations concerning form, intensity, and duration of postoperative treatment. A well-trained physical therapist is of great importance during the postoperative treatment regimen. Advantages might be seen on different levels, if a home exercise (HE) program was made available to the therapist and patient. An easier explanation of exercises would save time. Larger intervals in between sessions could also be convenient for patients and overloaded therapists. This would lead to a decrease in costs without trade-offs in patient outcome.

One big challenge the German health system faces is the fact that postoperatively most patients are supervised by less-specialized general practitioners instead of specialized hand surgeons. In many cases, these patients are also treated by therapists without specialized hand training.

## Purpose of the study

With this in mind, it can be advantageous if patients could receive a professional HE program to support them and their therapists. We want to assess the potential benefit of such a

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program with the next study. Therefore, we want to compare 2 different postoperative regimens. Our hypothesis is that the conventionally prescribed physical therapy (PT) is superior to an HE program where patients themselves are responsible for the execution of the exercises.

## Methods

The study was approved by the University Ethics Committee (no. 254/10), and written consent was given by each patient. The patients were divided into 2 different postoperative treatment groups using standardized controlled block randomization. Randomization list was created by a computer program (http://sealedenvelope.com/). Our trial design did not allow for blinding. Strict inclusion and exclusion criteria were chosen to ensure comparability between the 2 groups. Included were patients who suffered an isolated diaphyseal or metaphyseal second to fifth metacarpal fracture (Table 1). The fracture either led to a rotational error, a shortening of at least 5 mm, or volar dislocation higher than 10° (index and middle fingers) or higher than 30° (ring and small fingers). Surgical treatment with screws or plates provided mobilization stability. Intramedullary nailing was not included. Because of our strict inclusion criteria, sample size was small and sample size calculation was not performed. In preparation of this study, a total case number of 60 patients was deemed feasible when looking at the caseload of patients over the previous years. All surgeries took place between 2009 and 2014. Exclusion criteria were younger than 18 or older than 60 years, joint fractures, comminuted fractures, functionally relevant accompanying injuries (ie, tendon injuries), previously sustained damage to the hand, complications (ie, wound infection, implant failure, complex regional pain syndrome), psychological illness, lacking cognitive abilities, or lacking compliance.

All patients wore a functional dorsal orthotic device for 2 weeks postoperatively that was custom made of Light Cast (Lohmann & Rauscher, Germany) and fixated using an elastic wrap (Hartmann, Germany) (Fig. 1). Metacarpophalangeal joints (MCPJs) were flexed at 70°, and proximal interphalangeal joint (PIJ) and distal interphalangeal joint (DIJ) were allowed to move freely. After 2 weeks, the sutures and orthotic device were removed.

## Types of postoperative treatment

Patients in both groups were followed up by a hand surgeon at 2-week intervals over the first 3 months postoperatively.

Group 1 represented the PT group. Two weeks after surgery, all patients received 12 units of PT consisting of 30 minutes each over the course of 6 weeks (postoperative week 3-8). Neither the patients' choice of therapist nor the performed training exercises were controlled for in the study. As is customary, the therapists were instructed to teach exercises to the patients that they can autonomously perform at home. Compliance was verified through the notes of the PT on the prescription and by asking the patients themselves. To recreate an everyday routine setting, no further influence was taken.

Patients in the HE group also began exercising after 2 weeks postoperatively for a period of 6 weeks. They were given a booklet containing individual exercises, a written manual, and pictures (Table 2). The exercise booklet was designed by hand surgeons and physical therapists who specialized in treating hand injuries and training other therapists. After reading the booklet, all patients' questions concerning the exercises were answered by a hand surgeon. Patients were advised to discontinue exercises if their pain was excessive. The booklet also contained information about repetitions, intensity, periods of rest, and provided a checklist to sign off the performed exercises. A weekly diary to write down anything noteworthy was included. The exercises were supposed to be performed over a period of 6 weeks. Each day consisted of 3 exercise cycles (morning, midday, and evening) with each cycle containing 4-6 exercises and lasting 20-30 minutes. The exercises began to modify after the first week addressing the different states of scar tissue formation and fracture healing. During the first 2 weeks, focus was placed on minimizing restrictive scar tissue formation, reducing soft tissue edema, and increasing active and passive mobilization exercises. In weeks 3 and 4, dexterity exercises were introduced. These exercises did not involve resistance but required a higher level of muscular activity, especially in the intrinsic muscles. During the final 2 weeks, exercises were carried out against moderate resistance to build up muscle strength. Meanwhile, the exercises to prevent scarring were continued throughout the whole 6 weeks.

After reaching postoperative week 8, both patient groups continued to work on their individual limitations independently. Those limitations (scar management, decreased range of motion [ROM], or strength) were assessed by a hand surgeon. The next exercises did not necessarily end after the 12-week follow-up but after full ROM or patient satisfaction was achieved.

## Follow-up

This study was not blinded because all examinations and measurements were performed by the authors. During the follow-ups, general patient data and secondary diagnoses relevant to the healing process (nicotine abuse and diabetes) were recorded.

Routinely, the metacarpals were X-rayed with standard views (anterioposterior and oblique) directly postoperatively and after 6 weeks. The fractures were divided into proximal and distal

**Table 1**
Location, type, and kind of osteosynthesis of the metacarpal fractures

| Location | Type | PT group | | | | HE group | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Treatment | | | | Treatment | | | |
| | | Subtotal | POS | SOS | Total | Subtotal | POS | SOS | Total |
| Distal metaphysic | Transverse | 2 | 2 | 0 | 8 | 1 | 1 | 0 | 6 |
| | Oblique | 4 | 3 | 1 | | 3 | 3 | 0 | |
| | Spiral | 2 | 1 | 1 | | 2 | 0 | 2 | |
| Epiphysis | Transverse | 5 | 5 | 0 | 16 | 6 | 6 | 0 | 18 |
| | Oblique | 6 | 5 | 1 | | 9 | 6 | 3 | |
| | Spiral | 5 | 3 | 2 | | 3 | 1 | 2 | |
| Proximal metaphysis | Transverse | 1 | 1 | 0 | 6 | 0 | 0 | 0 | 6 |
| | Oblique | 4 | 4 | 0 | | 3 | 3 | 0 | |
| | Spiral | 1 | 1 | 0 | | 3 | 2 | 1 | |

PT = physical therapy; HE = home exercise; POS = plate osteosynthesis; SOS = screw osteosynthesis.

**Fig.1.** The dorsal orthotic device restricts the extension in the metacarpophalangeal joint but not the movement in the proximal and distal interphalangeal joints. Therefore, the fracture is protected directly by the device and in addition by the tension of the extensor tendon.

metaphyseal or diaphyseal fractures. In addition, the fractures were subdivided into transverse, oblique, and spiral fractures.

ROM was measured at weeks 2, 6, and 12 for all 3 finger joints of the injured finger and the contralateral noninjured finger using the neutral zero method.

The neutral zero method measures a joint's extent of motion based on a standard initial position. This neutral zero position corresponds to the kind of joint position that is normal for a healthy person in an upright position with adjacent arms, palms on thighs, and parallel feet. The deflection movement of a joint in a plane is measured. The deviation from the neutral zero position to the end position is given in degrees. The documentation of a measurement is carried out according to the following pattern: mobility direction (proximal/toward the body) – 0 – mobility direction (distal/away from the body). The classification of the measured ROM is carried out by comparing the results with the healthy side and with standard values of healthy adults or people of the same age.

Grip strength of both hands was measured using the Jamar dynamometer (Baseline, Fabrication Enterprises Inc., USA) (middle grip position) at weeks 6 and 12. All measurements were taken in accordance with the recommendations of the American Society of Hand Therapists.[8] Sitting in a standardized position, the maximum grip strength was measured 3 times, alternating between sides, starting with the healthy hand. The grip was held for 4 seconds, and the pause between grips lasted 30 seconds. If the last measurement delivered the highest grip strength, additional measurements were added until the last grip was not the strongest.[9] The mean value was calculated using the valid measurements. Earlier studies recommended considering a 10% higher grip strength level when using the dominant hand.[10] Although recent studies have shown that this only applies to right-handed people, whereas left-handed people roughly show the same strength in both hands.[11,12] Therefore, we only applied the 10% correction factor to right-handed patients. The mean value of all measurements (weeks 6 and 12) of the unaffected side was used as the 100% reference. The values of the injured side were then put into perspective.

For subjective evaluation of the functional outcome, the Disabilities of the Arm, Shoulder and Hand (DASH) score has been determined at weeks 6 and 12. The DASH score is an internationally accepted tool to evaluate the subjective functionality of the upper extremity. It determines to what extent the patient feels limited when performing everyday activities. The patient can grade the degree of limitation into 5 levels ranging from no limitation at all to complete inability to perform the activity. Each question is then awarded a value from 1 to 5 points. The DASH score tests 30 different activities or aspects of daily life. The values of all questions are added up and converted to a scale from 0 to 100, where 0 correlates with no limitations and 100 with complete inability to perform the activities.

## Statistics

All measured data are presented descriptively. The values for ROM, grip strength, and DASH score are shown including mean values and standard deviation.

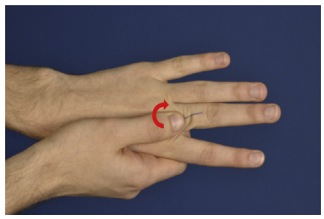
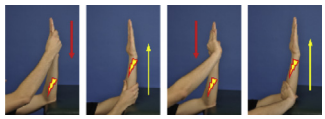
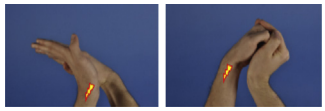
Normal distribution was tested using the Shapiro-Wilk normality test. Apart from 1 exception (ROM MCPJ, PT group week 2), there was no normal distribution. We therefore used the Wilcoxon rank sum test to compare the 2 groups and the signed rank test to compare the different points in time. The level of significance was set at $P < .05$.

## Results

The collective consisted of 60 patients suffering from a metacarpal fracture who were divided into 2 postoperative treatment groups using block randomization. The PT group consisted of 23 men and 7 women with a mean age of 31.9 ± 14.6 years (range, 18-60). The HE group consisted of 22 men and 8 women with a mean age of 32.4 ± 15.4 years (range, 18-60). There were no significant differences concerning age and sex between the groups.

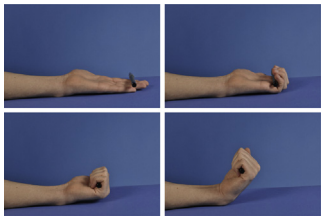
One patient in the HE group suffered a refracture through a fall on his hand and was therefore excluded from the study. Two patients in the PT group showed delayed wound healing with prolonged wound secretion until the fourth and sixth days postoperatively. In both cases, the wounds healed without any necessary therapy, and PT started as planned.

**Table 2**
Detailed weekly schedule of an HE program

| Number | Description | Example images | Duration/frequency |
|---|---|---|---|
| Week 1 | | | |
| 1 | Scar treatment<br>1. Move the thumb of your unaffected hand in small circles around the scar. Apply only soft pressure. Move toward the scar.<br>2. Move your thumb of the unaffected hand in small circles directly on the scar. Make sure to gently move the scar tissue. |  | 5-10 min |
| 2 | Camomile bath<br>*Preparation*: bowl with warm camomile tea (2 teabags)<br>Place your entire hand in the bowl. Try to flex and extend your fingers in the water. If necessary, use your unaffected hand to support the movements of your fingers (see exercise 4).<br>*Procedure*: keep the hand in the water for 2 min. Then, start with 3 sets of 10 repetitions each. Take a break after every set for 30 s.<br>Please apply some moisturizing lotion to your hands after the camomile bath, especially on the scar (eg, panthenol lotion) |  <br>  | 5 min |
| 3 | Decongestive exercise<br>Place the arm of your affected hand down on a table. The hand should be positioned higher than the elbow, and the elbow should be positioned higher than the shoulder.<br>Start massaging down the affected hand beginning from the fingertips and moving toward the armpit. |  | 5 min |
| 4 | Fist<br>Open and close the fingers as far as possible. In both end positions, the movement of the fingers should be supported with the unaffected hand. |  | 3 times 10 repetitions |
| 5 | Crocodile<br>1. Closed crocodile jaws = contact between thumb and fingertips. Make sure only to flex the MCPJ. The PIJ and DIJ should remain fully extended.<br>2. Open crocodile jaws = quickly stretch and spread your fingers |  | 3 times 10 repetitions |
| Week 2 | Perform the exercises of the first week with the same frequency. | | |
| 6 | Additional exercises<br>**Steal and hide the cherries**<br>Stretch the fingers of the affected hand and move your arm upward. Then, make a fist and move your arm downwards. The arm should remain close to your body. The back of your hand is pointing downward. |  | 3 times 10 repetitions |

(*continued on next page*)

**Table 2** (*continued*)

| Number | Description | Example images | Duration/frequency |
|---|---|---|---|
| Weeks 3 and 4 | Please skip exercises 3, 4, and 5. Please perform the other exercises of the second week with the same frequency. | | |
| 7 | Additional exercises<br>**Roll up pen**<br>Place the back of your hand down on a table. The lower arm remains free. Place a pen on your fingertips and roll up the pen with your fingers, whereas the back of your hand remains on the table. |  | 3 times 10 repetitions |
| 8 | Pegs<br>Open the peg using the affected and unaffected fingers. |  | 10 times per finger |
| Weeks 5 and 6 | Please skip exercises 7 and 8. Please perform the other exercises of the third and fourth weeks with the same frequency. | | |
| 9 | Additional exercises<br>**Squeeze ball**<br>Place a soft tennis ball on the palm of your hand and press it equally using all fingers. Apply only as much power, that you would not feel any pain. Fully extend your fingers and relax slowly after 2-3 s. |  | 3 times 10 repetitions |

HE = home exercise; MCPJ = metacarpophalangeal joint; PIJ = proximal interphalangeal joint; DIJ = distal interphalangeal joint; = affected hand; = direction of motion.
Please perform the exercises 3 times a day with a 30-second break between the repetitions.

Secondary diagnoses relevant to the healing process are listed in Table 3. In spite of these diagnoses, all 59 fractures healed in axial alignment after 6 weeks independent from localization, type of fracture, and surgical technique.

Twenty-three of 29 patients in the HE group documented their compliance using the booklet with an exercise completion rate of 98%. The remaining 2% neglected to perform scar management exercises in weeks 5 and 6. Five patients did not document their exercises, and 1 patient did not return the booklet. All patients in PT group received 12 documented sessions of PT (2 sessions per week) and were also instructed to exercise autonomously.

In both groups, the ROM in the MCPJs of the affected finger was still severely reduced (42.5° in PT and 46.5° in HE) 2 weeks after surgery (Fig. 2). Compared with the MCPJ of the corresponding finger of the healthy hand, the ROM only reached 48.7% (PT) and 52.8% (HE), respectively.

The PIJ and DIJ already showed a good ROM compared with the healthy side: 88.3% (PT) and 86.8% (HE) in the PIJ and 89.1% (PT) and 89.8% (HE) in the DIJ.

The ROM of the MCPJ improved significantly in both groups to values of 61.7° (PT) and 68.5° (HE) at week 6 ($P < .0001$). After 12 weeks, the improvement was also statistically significant with the ROM reaching 73.3° (PT) and 82.2° (HE) ($P < .0001$). The ROM in the PIJ and DIJ only increased a little due to the good initial function.

In the end, the total ROM of the affected fingers in the HE group (256°) was significantly higher than in the PT group (245°) ($P = .013$). Neither the fracture site nor the affected finger leads to any relevant outcome differences.

Grip strengths of the injured hand and contralateral side are shown in Figure 3. In both groups, the relative grip strength compared with the contralateral side was still severely reduced (68% in PT and 71% in HE) 6 weeks after surgery. After 12 weeks, the relative grip strength increased significantly to 91% (PT) and 93% (HE), respectively ($P < .0001$). There were no statistically significant differences between the 2 groups at both points in time.

The subjective evaluation of the functional outcome was assessed 6 and 12 weeks after surgery (Fig. 4). At 6 weeks, the mean DASH score was 30 in the PT group and 25 in the HE group. After 12 weeks, the values were significantly lower (16 in PT and 14 in HE) ($P < .0001$). There were no statistically significant differences between the 2 groups at both points in time.

**Table 3**
Secondary diagnoses relevant to the healing process

| Diagnoses | PT group | HE group |
|---|---|---|
| Smoking | 7 | 5 |
| Diabetes mellitus | 1 | 3 |
| Coagulation dysfunction | 0 | 1 |

PT = physical therapy; HE = home exercise.

## Discussion

In this prospective randomized study, we compared the functional results of 2 different postoperative treatment concepts after surgically treated metacarpal fractures. To minimize external influences, strict inclusion and exclusion criteria were enforced. Displaced fractures with rotational errors, axial misalignment, or

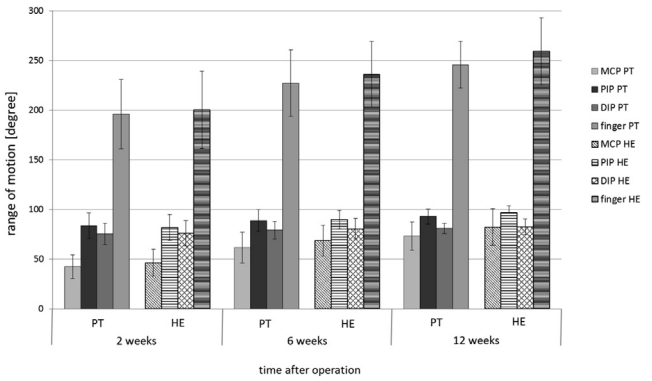



**Fig. 2.** Range of motion of each of the 3 finger joints and the complete finger. Illustrated are the means and standard deviations for both groups. MCP = metacarpophalangeal; PT = physical therapy; PIP = proximal interphalangeal; DIP = distal interphalangeal; HE = home exercise.

shortening with indication for surgical treatment in accordance with current guidelines were included.[1] Surgical treatment using open reduction and internal fixation provided mobilization stability. Although there is still a lot of controversy concerning postoperative therapy of metacarpal fractures,[3,13-15] it is generally accepted to begin early functional mobilization when the necessary stability is reached to prevent soft tissue scarring and contractures.[13] Particularly, because Feehan et al[16] even described that early movement had a positive effect on fracture healing. Although the significance of early functional mobilization has been known for some time now, a multicenter study performed by Küntscher et al[7] in 2003 showed that in Germany only one third of metacarpal fractures are treated with early functional mobilization.

During the first 2 weeks after surgery, all patients in this study wore orthotic devices to protect the fixation, reduce pain, and promote wound healing. The orthotic devices limited motion of only the MCPJ. The PIJs and DIJs were unrestricted. The flexed position of the MCPJ tensions the extensor tendon complex that provides additional protection to the fracture site.[17] After 2 weeks, the orthotic device was removed, and free functional treatment was started. After 6 weeks, strengthening exercises were added. The HE program provided detailed instructions on scar treatment, mobilization exercises, coordination, and strength improvement.

The significance of early patient involvement into the postoperative treatment is well known. Harth et al[18] have shown that in a variety of hand injuries a patient-oriented rehabilitation regimen leads to better functionality, higher patient satisfaction, and earlier return to work. Guzelkucuk et al[19] designed a postoperative treatment regimen that included everyday activities for young people suffering from different hand injuries. They were able to show that this treatment form was superior to mere active or passive mobilization exercises. Freimark et al[20] also recommended an HE regimen for patients with phalangeal or metacarpal fractures. It contains everyday activities alongside classic PT. In a study done by Bryan and Kohnke,[21] the time spent on the performance of daily HEs totalled 1 or 2 hours. All those studies emphasize the significance of home exercising, without mentioning a concrete regimen with which patients can work independently.

Al-Qattan[22] examined a collective of 42 patients with 54 metacarpal shaft fractures that were treated conservatively using a volar wrist orthotic device and immediate finger mobilization. The total ROM of the injured finger was 234° after 2 weeks, 241° after 6 weeks, and 253° after 12 weeks. Comparing this to our collective, the 2-week ROM in both groups (196° and 200°) was considerably lower, while improving until week 12 and reaching a comparable value thereafter. In our opinion, this is partially due to orthosis, which provides security to the fracture site but limits extension in the metacarpal joint during the first 2 weeks after surgery. Also, scar tissue formation after surgery could be responsible for the difference in ROM in the early phase. Our patients' advantage is that they can begin free functional mobilization after 2 weeks without any orthosis and can make up for the initial motion deficit. Ozer et al[4] examined a collective of 14 patients over 19 weeks after plate-screw fixation of extra-articular metacarpal fractures. The ROM of 228° was slightly lower than in our collective after 12 weeks.

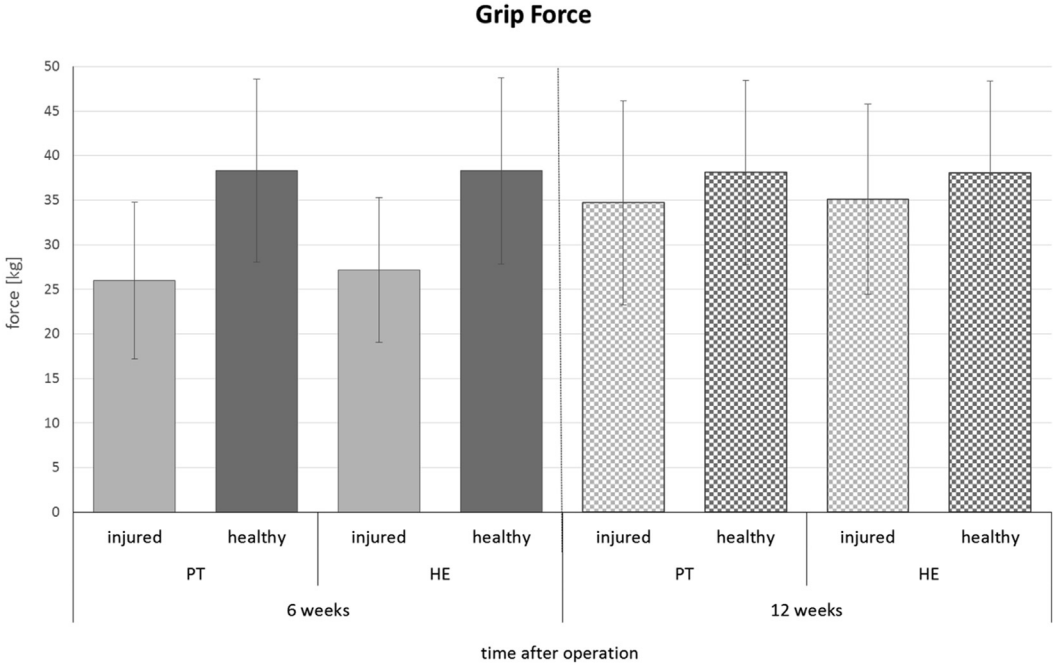



**Fig. 3.** Grip strength of both hands 6 and 12 weeks postoperatively. Illustrated are means and standard deviations. PT = physical therapy; HE = home exercise.

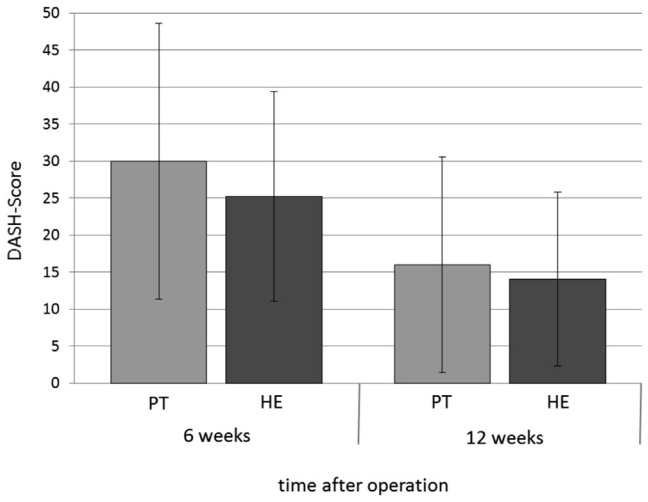



**Fig. 4.** DASH score of both groups 6 and 12 weeks postoperatively. Illustrated are means and standard deviations. DASH = Disabilities of the Arm, Shoulder and Hand; PT = physical therapy; HE = home exercise.

Dumont et al[23] introduced a collective of 12 patients whose metacarpal fractures were treated with an absorbable plate. The mean ROM was 234° after 6 months. Assuming that the mentioned studies used similar surgical techniques, we most likely attribute the superior ROM in our collective to the type of postoperative treatment. Unfortunately, the authors do not specify their postoperative regimens. Schädel-Höpfner et al[24] examined 30 distal metaphyseal fractures that were reduced in a closed fashion and fixated with K-wires. Follow-up was after 6 months. The postoperative treatment consisted of 6-10 sessions of PT. Intramedullary placed wires lead to a free ROM, whereas retrograde wiring lead to a deficit in ROM of 15°. In comparison, our collective showed a deficit in ROM of 17° in group 1 and 8° in group 2 at the MCPJ. Considering the open reduction technique and scar tissue formation, this is a satisfying result.

Although grip strength in our collective was considerably decreased in both groups after 6 weeks, it improved clearly until week 12. Although strengthening exercises were not started until week 6, the relative grip strength compared with the uninjured hand was 91% (G1) and 93% (G2). Tavassoli et al[25] examined conservatively treated metacarpal fractures after 9 weeks and found relative grip strength ranging from 85% to 90%, which is slightly inferior in comparison to our collective. Six months after surgically treated fractures of the fifth metacarpal, Schädel-Höpfner et al[24] found no residual grip strength deficit. Wong et al[5] also examined surgically treated fractures of the fifth metacarpal and found a grip strength level between 95% and 97% relative to the contralateral side. These data suggest that after a comparable follow-up interval grip strength in both our groups will continue to normalize.

The DASH score shows moderate limitation of everyday activities in both groups (30 in group 1 and 25.2 in group 2) 6 weeks after surgery. Both groups improved significantly until week 12, reaching scores of 16 (G1) and 14.1 (G2). Nevertheless, Hofmeister et al[26] reached considerably lower scores of 8 and 9 after 3 months. One has to take into consideration that this collective consisted solely of fractures of fifth metacarpals that were treated nonoperatively. Ozer et al[4] reached a DASH score of 8.07 after plate fixation, which was also lower compared with our collective. Because the follow-up took place 7 weeks later compared with our study, the patients had some additional recovery time.

Comparing our groups to one another, there were no significant differences concerning X-ray results and rate of complications. All fractures were aligned properly that can be attributed to the strict exclusion criteria—no soft tissue damage, no comminuted fractures, and no additional fractures of other bones. Only 1 patient had to be excluded after suffering plate failure due to another fall.

Advantages of the HE group are the elimination of travel and waiting time at the therapist's office. Patients were not bound to certain appointments. The postoperative treatment for the HE group always took place in the same fashion. Exact descriptions and depictions of the exercises were made available to the patients. That way, the chance of remembering every part of the postoperative treatment was increased. The effectiveness of this program can also be attributed to the increase of time invested by the patient. One advantage of the PT group was the constant feedback patients got from their therapists. In addition, the therapist was able to address individual problems the patient might have been concerned with. It is clear that certain exercises (eg, traction treatment for contractures) cannot be performed by patients themselves but need to be addressed by an experienced therapist. When put into perspective, HEs will never reach the effectiveness of professional PT using the same amount of time.

However, our hypothesis that classic PT leads to better results was not confirmed. Comparing both groups and focusing on total ROM, the HE group (256°) reached a significantly better result after 12 weeks than the PT group (245°). In our opinion, this small difference after a relatively short follow-up will not prove to be clinically relevant. Because grip strength and DASH score showed no significant differences, the functional results of both groups can be considered equal.

The HE program in this study has to be considered a prototype. It was established by hand surgeons in cooperation with specially trained physical therapists but does not represent a recognized or approved method of postoperative treatment for metacarpal fractures.

There are a number of methodological weaknesses in our study that make it difficult to attribute the differences between the groups solely to the format of exercise delivery. First, the randomization list was not blinded from the study investigators who also designed and provided the treatment and evaluated the outcomes. Therefore, the potential for bias is high. Second, patients in the HE group were given exercise diaries and monitored for adherence, whereas the PT group was not. It is possible that the focus on exercise adherence was the reason for differences between the groups. Third, the provider, type, and dosage of exercises was not standardized or monitored in the PT group, so we do not know what that group received. Most definitely, there was a significant difference in the therapists' quality of work, and we do not know if they were especially trained for hand injuries. During the follow-up appointments, we did not comment on type or intensity of potentially instructed HEs in the PT group. Therefore, differences between the groups may relate to the fact that we are comparing hand professional exercise prescription to nonspecialty exercise prescription.

Short follow-up intervals (every other week) may represent another flaw in our study. Because this interval is often not the case in German hospitals, our HE group could have benefitted from more attention and instruction than patients receiving regular PT. Therefore, it might be possible that the results of the HE group were better than they would be in daily hospital routine. Also, our group sizes are relatively small due to our strict inclusion and exclusion criteria. Because the differences between both groups are not significant in most cases, a larger cohort might be needed to increase the statistical power of our findings.

## Conclusion

Both HE provided by a hand professional and uncontrolled PT provided by nonspecialized providers were effective in hand rehabilitation after metacarpal fracture. Our study was not able to find conclusive differences, partially due to limitations in our study size and design. Because HE provided by a hand professional can be effective and is an acceptable option to achieve good outcomes, our study suggests that attention to exercise prescription, dosage, and adherence monitoring are important considerations in future trials and clinical practice.

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#1. The design of the study was
   a. qualitative
   b. retrospective cohort
   c. RCTs
   d. case series

#2. The ROM which was a focus of the data was
   a. MP
   b. PIP
   c. DIP
   d. supination

#3. All patient subjects were
   a. non thumb metacarpal fractures
   b. surgically fixated
   c. treated either by HE or PT
   d. all of the above

#4. The last data was collected at _____ weeks post op
   a. 2
   b. 6
   c. 12
   d. 24

#5. The data suggest that traditional PT showed significantly better outcomes than a home exercise program
   a. true
   b. false

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