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Functional outcomes in patients with metacarpal, proximal, and middle phalangeal fractures treated with osteosynthesis

Resultados funcionales en pacientes con fracturas de metacarpo, falanges proximal y media tratados con osteosíntesis

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ABSTRACT

Fractures of the metacarpals and phalanges of the hand are common in the working-age population and can significantly affect hand function. Surgical treatment with open reduction and internal fixation using plates is a commonly used technique; however, there is limited consensus in the literature regarding its functional outcomes. The objective of this study was to determine the functional outcomes in patients with fractures of the metacarpals, proximal phalanges, and middle phalanges, treated with open reduction and internal fixation using a dynamic compression plate (DCP) at Gustavo A. Rovirosa Regional High Specialty Hospital during the period 2022–2024. A prospective, observational, cross-sectional study was conducted. Forty-seven patients were included, and their medical records and postoperative consultations were analyzed. Functional outcomes were assessed using the Quick DASH questionnaire. Data analysis was performed using Microsoft Excel and SPSS. The study found that 87% of patients experienced no or mild disability, 91% achieved a full range of motion, and 100% regained normal sensation. These results support the effectiveness and safety of using DCP in the functional recovery of hand fractures.

Keywords: fractures metacarpal, phalanx, functional outcomes, internal fixation.

RESUMEN

Las fracturas de metacarpianos y falanges de la mano son frecuentes en la población en edad productiva y pueden afectar significativamente la funcionalidad de la mano. El tratamiento quirúrgico mediante reducción abierta y fijación interna con placas es una técnica comúnmente utilizada; sin embargo, existe un consenso limitado en la literatura respecto a sus resultados funcionales. El objetivo de este trabajo fue determinar los resultados funcionales en pacientes con fracturas de metacarpianos, falanges proximal y media, tratados con reducción abierta y osteosíntesis con placa de compresión dinámica (DCP) en el Hospital Regional de Alta Especialidad Gustavo A. Rovirosa durante el periodo 2022-2024. Para esto se realizó un estudio prospectivo, observacional y transversal. Se incluyeron 47 pacientes, cuyos expedientes clínicos y consultas posquirúrgicas fueron analizados. Los resultados funcionales se evaluaron mediante el cuestionario Quick DASH. El análisis de datos se efectuó con Microsoft Excel y SPSS. El estudio encontró que el 87% de los pacientes presentó discapacidad nula o leve, el 91% logró un rango de movimiento completo y el 100% recuperó la sensibilidad normal. Estos resultados respaldan la efectividad y seguridad del uso de DCP en la recuperación funcional de fracturas de mano.

Palabras clave: fracturas de metacarpianos, falanges, resultados funcionales, fijación interna.

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INTRODUCTION

Phalangeal fractures account for 10% of all fractures. They are most common between the ages of 20 and 50. In most cases, hand fractures can be treated non-surgically with satisfactory functional and aesthetic results. For approximately 50 years, the advent of advanced imaging, improved implants, and a better understanding of fracture healing have led to new surgical options (Taghinia & Talbot, 2019).

Open reduction and internal fixation (ORIF) with plates provides the necessary stability for early and more intensive mobilization. On the other hand, the poor final results and the high number of complications reported by some authors mean that, even today, its effectiveness is debated (Taghinia & Talbot, 2019).

Osteosynthesis plates for minifragments in the hand were introduced to the market several years ago, replacing traditional steel plates. Their multiple designs, many of which are pre-contoured, their delicate finish, and low profile allow for rigid internal fixation with less interference with normal tendon gliding, and provide the possibility of early joint mobilization and better functional outcomes (Lögters et al., 2017).

Currently, there is no comparative study between the different surgical options, nor has a study been conducted on the functional outcomes of patients who underwent surgery with different materials to reach a definitive consensus on which surgical material is best for phalangeal fractures. Considering this, this study aimed to determine the functional outcomes of patients who underwent open reduction with a dynamic compression plate (DCP) for fractures of the middle and proximal phalanges, given the contradictory recommendations in the literature regarding surgical management.

METHODOLOGY

This study was designed as a prospective, non-experimental, and observational investigation. This methodology allowed for the direct evaluation of functional outcomes in patients who underwent open reduction of metacarpal fractures, as well as fractures of the middle and proximal phalanges of the hand, without intervening in the treatment or altering the natural course of the surgical procedure. This design was chosen for its ability to observe and record postoperative effects over a specific period, enabling a precise assessment of the patients' clinical

evolution.

The study population consisted of all patients who underwent plate osteosynthesis for the treatment of metacarpal and middle and proximal phalangeal fractures of the hand at the Gustavo A. Rovirosa Pérez Regional High Specialty Hospital between 2022 and 2024. The study population included those patients who met the established inclusion and exclusion criteria. This patient group was chosen due to the frequency and clinical relevance of fractures in the hand's bone structures, which present a significant challenge in terms of treatment and rehabilitation.

The sample used in this study was non-probabilistic, meaning that a random selection process was not used. Instead, all patients who underwent open reduction and stabilization surgery for fractures of the metacarpals, middle phalanges, and proximal phalanges of the hand between 2022 and 2024 were included. This type of sample was selected due to the accessibility of clinical records and the nature of the surgical procedure, which allowed for the inclusion of a representative number of cases without the need for randomization.

Patients of both sexes, aged between 18 and 80 years, who underwent plate osteosynthesis for fractures of the metacarpals or middle and proximal phalanges of the hand between 2022 and 2024 were included in the study. These patients were selected because plate osteosynthesis surgery is one of the most frequent interventions in the treatment of complex fractures of the hand, and their inclusion allows for an effective evaluation of the functional results in this type of patient.

Patients treated with intramedullary screws or pins were excluded from the study, as these osteosynthesis methods were not the primary focus of this research. Patients who underwent closed reduction surgery were also excluded, since this technique does not involve the use of plates and would not allow for a proper comparison with cases treated with osteosynthesis. Patients with distal phalangeal fractures of the hand were also excluded, given that this type of injury has different anatomical and functional characteristics, which could bias the results. Finally, patients discharged with conservative management were excluded, as they would not undergo a surgical intervention that would allow for the evaluation of the effects of osteosynthesis.

Data collection was carried out through a comprehensive review of the medical records of the selected patients, supplemented by the post-surgical consultations the patients had during follow-up. This approach allowed for obtaining detailed information on the evolution of the

fracture, the type of surgical treatment received, and the progress in patients' functional recovery. The Quick DASH questionnaire (Disabilities) was used to assess post-surgical functional outcomes. The Arm, Shoulder, and Hand Questionnaire (ALQ) is an internationally validated and widely used instrument for upper limb function. This questionnaire measured the disability and symptoms associated with hand and arm problems, providing a useful tool for postoperative assessment.

Once the data were collected, they were organized using Microsoft Excel and SPSS software to facilitate the analysis of the variables involved in the study. Descriptive statistical calculations were performed to obtain the distribution of the variables and the patients' postoperative functional outcomes. In addition, inferential statistical analysis of possible relationships between the treatment variables and functional outcomes allowed conclusions on the effectiveness of plate osteosynthesis in this fracture type.

This study was conducted in strict accordance with the ethical principles established in the Declaration of Helsinki, as updated in 2013, particularly regarding research involving human subjects. Furthermore, it complied with Article 98 of the General Health Law, which regulates research involving human subjects in Mexico. To ensure the ethical validity of the study, registration and approval of the research protocol were requested from the teaching committee of the Gustavo A. Rovirosa Pérez Regional High Specialty Hospital. This institutional approval process was essential to ensure that the study met the ethical and legal standards required for clinical research.

RESULTS AND DISCUSSION

It was analyzed 47 records of patients who underwent surgery for fractures of the metacarpals and proximal and middle phalanges, corresponding to 23 cases in 2022, 15 in 2023, and 9 in 2024. It was observed that the majority of cases corresponded to men, representing 85% of patients, while women represented the remaining 15%. The most frequent fractures were fifth metacarpal fractures (19% of cases), combined first and second metacarpal fractures (8.5%), proximal phalanx fractures of the second finger, and middle phalanx fractures of the fourth and fifth fingers, each representing 4.3%.

Open fractures totaled 23 cases, representing 49% of the total, while closed fractures

accounted for 51%. Regarding the affected upper extremity, the left extremity was more frequently involved, with 28 cases (60%), while the right extremity was affected in 19 cases (40%).

The most frequent injury mechanism was direct contusion, representing 43% of cases, followed by motorcycle accidents (36%), blunt force trauma with a machete (11%), milling (4%), firearm projectiles (4%), and one case of bite (2%). The majority of postoperative patients achieved a full range of motion (91.49%), while 8.51% had an incomplete range of motion (Table 1).

Table 1. Degree of movement of post-operative patients with fractures of metacarpals and proximal and middle phalanges of the hand

Degree of movement	Frequency absolute	Percentage
Complete	43	91.49
Incomplete	4	8.51

No or mild disability was found in 87%, mild or moderate disability in 4% and moderate disability in 9% of patients (Table 2).

Table 2. Functional status of post-operative patients with fractures of metacarpals and proximal and middle phalanges of the hand

Level of functionality	Frequency absolute	Percentage
No or slight disability	41	87.23
Mild or moderate disability	2	4.26
Moderate disability	4	8.51
Moderate to severe disability	0	0.0
Severe disability	0	0.0

Muscle strength was assessed using the Daniels scale (Table 3). The majority had maximum muscle strength with resistance, i.e., grade 5, representing 82.98%. Four patients had partial muscle strength with resistance, i.e., grade 4, and four patients had grade 3, muscle strength that overcomes gravity, representing 8.51% each.

Table 3. Manual muscle strength of post-operative patients with fractures of the metacarpals and proximal and middle phalanges of the hand

Daniels scale	Frequency absolute	Percentage
Grade 5	39	82.98
Grade 4	4	8.51
Grade 3	4	8.51
Grade 2	0	0.0
Grade 1	0	0.0
Grade 0	0	0.0

Table 4 presents the functional status of patients who underwent surgery for fractures of the metacarpals and proximal and middle phalanges of the hand, classified according to the mechanism of injury. The most frequent mechanism was direct contusion, with 20 patients having no or mild disability. Motorcycle trauma followed in frequency, with 15 patients presenting with no or mild disability and 2 with moderate disability. Injuries from machetes, grinders, firearms, and bites were less common, and most of these patients presented with no or mild disability. In total, 41 patients had no or mild disability, 2 had mild to moderate disability, and 4 had moderate disability.

Table 4. Functionality of post-operative patients with fractures of metacarpals and proximal and middle phalanges of the hand according to the mechanism of injury

Mechanism of injury	No or slight disability	Mild or moderate disability	Moderate disability	Total
Direct contusion	20	0	0	20
Motorcycle	15	0	2	17
Machete	3	1	1	5
Windmill	0	1	1	2
Firearm projectile	2	0	0	2
Bite	1	0	0	1
Total	41	2	4	47

When analyzing the relationship between the injury mechanism and functionality by the Quick DASH scale, a significant relationship was found with a p-value of 0.007 by the Chi-square test, since the direct contusion fractures had a mild or zero disability in their entirety, while the machete or mill fractures obtained a mild to moderate or moderate disability.

In open fractures, more cases of disability were found: 2 cases of mild to moderate

disability and 3 cases of moderate disability, while in closed fractures, only one case of moderate disability was found (Table 5).

Table 5. Functionality and degree of exposure of metacarpal and proximal and middle phalangeal fractures of the hand in postoperative patients

Exposure	No or slight disability	Mild to moderate disability	Moderate disability	Total
Exposed	18	2	3	23
Closed	23	0	1	24
Total	41	2	4	47

When analyzing the relationship between the degree of exposure and muscle strength, a significant relationship was found with a p-value of 0.044 by the Chi-square test, finding that open fractures obtained a lower score on the muscle strength scale and closed fractures had a higher score, with almost all of them having the highest score.

Gardenal et al. (2018) conducted a prospective cohort study to evaluate functional outcomes of working patients with phalangeal fractures treated with plates and to establish poor prognostic factors. Between 2012 and 2014, they evaluated 55 patients who underwent plate osteosynthesis for phalangeal fractures. The majority of patients in the study were male. Adequate consolidation was found in all patients, with excellent mobility in 35%, good in 55%, and poor in only 9%. The average DASH score was 18.53.

The study was conducted in 47 patients, 40 of whom were men and 7 women. Adequate consolidation was found in all patients, and 41 of the 47 patients (87%) had no or mild disability. Two patients had mild to moderate disability, and only four patients (9%) had moderate disability. The average Quick DASH score was 15.2. These results are similar to those found in the study by Gardenal et al. (2018); however, our study determined a better Quick DASH score post-surgery.

Katayama et al. (2020) conducted a prospective study evaluating the clinical and radiological outcomes of locking plate fixation in the treatment of unstable fractures of 11 metacarpals, 15 proximal phalanges, and eight middle phalanges in 34 consecutive patients from October 2011 to December 2016. The mean postoperative range of motion of the two interphalangeal joints and the metacarpophalangeal joint was 82% of the contralateral hands. Stiffness was observed in 10 of 34 cases at the last follow-up.

In contrast, our study reported a full active range of motion in 43 of 47 patients, corresponding to 91%, and only 4 patients had an incomplete active range of motion, representing only 9% of the study population. This could be related to the fixation technique, since in the study by Katayama et al. (2020), lateral approaches were used, and therefore lateral fixations were performed, while in our study, only dorsal fixations were performed, which involved less damage to the soft tissues surrounding the fracture.

Differences in the proportion of disability or range of motion compared to other studies may be explained by variations in inclusion criteria, surgical technique used, surgical time, and adherence to postoperative rehabilitation (Serban et al., 2025). However, overall, the results of this study reinforce the evidence supporting DCP plate osteosynthesis as a safe and effective alternative for the treatment of hand fractures, especially in young and active patients.

CONCLUSIONS

The use of DCP osteosynthesis for the treatment of metacarpal and proximal and middle phalanx fractures has proven to be effective, achieving high rates of functional recovery. Most patients achieved a full range of motion, adequate muscle strength, preserved sensation, and minimal or no disability. These results support the use of DCP as a reliable and safe option in the treatment of complex hand fractures, especially in young and active patients. Its adoption as a first-line treatment is recommended, along with standardized follow-up and rehabilitation protocols to optimize recovery. Additionally, it is suggested to conduct multicenter studies with a larger number of patients and comparisons between different osteosynthesis methods to strengthen the clinical evidence and evaluate differences in recovery times and long-term functionality.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: Mónica A. Martínez. **Data curation:** Mónica A. Martínez and Paola Santos. **Formal analysis:** Mónica A. Martínez, Héctor I. Palomino, and Verónica G. Carrera. **Investigation:** Mónica A. Martínez and Paola Santos. **Methodology:** Mónica A. Martínez and Paola Santos. **Project administration:** Héctor I. Palomino and Verónica G. Carrera. **Software:** Verónica G. Carrera. **Supervision:** Héctor I. Palomino and Verónica G. Carrera. **Validation:**

Héctor I. Palomino and Verónica G. Carrera. **Visualization:** Héctor I. Palomino and Verónica G. Carrera. **Writing – original draft:** Mónica A. Martínez and Paola Santos. **Writing – review & editing:** Mónica A. Martínez, Paola Santos, Héctor I. Palomino, and Verónica G. Carrera.

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