

CASE REPORTS

Comparison of Osteosynthesis Using Plates and Screws Versus Kirschner Wire Fixation for Unstable Metacarpal Fractures: a Retrospective Clinical Study

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Summary

The hand is both a motor and sensory organ, and in terms of society, it is an organ of defense, of creation and an organ of expression. This is why hand surgery is very important and studies regarding the functional results of different treatments in order to treat injuries are necessary. In this paper, we presented the results of a retrospective clinical study in order to compare osteosynthesis using plates and screws (n=36) versus fixation using Kirschner wires (n=32) in order to treat metacarpal fractures of 68 patients. The functional outcomes were assessed using the DASH and the TAM score measured at two and twelve months from surgery. The DASH scores were lower (showing better results) in the PS group compared to the KW group, with a mean difference of 20.53 after two months and 6.41 after twelve months, while the TAM scores were higher (235° at two and 261° at twelve months in the PS group compared with 218° at two and 257° at twelve months in the KW group). Therefore, we concluded that osteosynthesis using plates and screws leads to better functional recovery than osteosynthesis using Kirschner wire.

Keywords: DASH, TAM, osteosynthesis, metacarpal fractures, periosteum

Rezumat

Mâna este un organ motor, dar și senzorial, astfel încât din punct de vedere social este un organ de apărare, de creație și de expresie. Din aceste motive, chirurgia mâinii reprezintă un domeniu foarte important și prin urmare, studii cu privire la rezultatele funcționale ale diferitelor tratamente cu scopul de a trata leziuni la acest nivel sunt necesare. În această lucrare, vă prezentăm rezultatele unui studiu clinic retrospectiv realizat cu scopul de a compara osteosinteza cu placă și șuruburi (n=36) cu broșele Kirschner utilizate în scopul de a reduce fracturi de metacarpiene pe un lot de 68 de pacienți. Rezultatele funcționale au fost evaluate prin prisma scorurilor DASH și TAM măsurate la 2, respectiv 12 luni. Scorurile DASH au fost mai mici în grupul PS comparativ cu grupul KW, cu o diferență medie de 20,53 la 2 luni și de 6,41 la 12 luni, în timp ce scorurile TAM au fost mai mari (235° la 2 luni și 261° la 12 luni în grupul PS comparativ cu 218° la 2 luni și 257° la 12 luni în grupul KW). În concluzie, osteosinteza cu placă și șuruburi duce la o recuperare funcțională mai bună comparativ cu osteosinteza cu broșe Kirschner.

Cuvinte cheie: DASH, TAM, osteosinteză, fracturi de metacarpiene, periost

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INTRODUCTION

Hand surgery is considered to be the biggest challenge for every plastic surgeon. The social value of the hand is appreciated by any individual, but mostly by plastic surgeons which are, par excellence, hand-working persons. When a hand injury is treated you must consider the Hippocratic concept which states that „healing is a matter of time but it is sometimes also a matter of opportunity”. The hand forms a functional unit with the forearm which is a high-precision machine, with multiples levers, who has tactile intelligence that ensure its auto-mechanism, being able to grab and maintain, in any spatial position, large and small tools invented by human genius. The hand is both a motor and sensory organ, and in terms of society, it is an organ of defense, an organ of creation and expression. This is why hand surgery is very important, both in medical and social terms, and any research in this domain has one purpose: improving the treatment of hand injuries in order to obtain functional results closer to the genetic scale of the divine creation. The purpose of this study was to assess different osteosynthesis techniques in order to establish which one is better in matters of functional results.

MATERIALS AND METHODS

Our research was a retrospective clinical study in order to compare the functional outcomes after the surgical treatment of the metacarpal fractures using two of the most used surgical techniques in hand fractures. Between 2013 and 2015, 68 patients were treated for closed displaced and unstable extra-articular metacarpal fractures. One of these two osteosynthesis methods were used after open reduction of the fracture: os-

teosynthesis using plates and screws (n=36) or Kirschner wires (K-wires, n=32). The data was collected from the patients, from the surgeons and from the statistical database of the Clinical Emergency Hospital of Bucharest. The following criteria were mandatory in order for the patient to be included in the study: age between 16 and 65 years old, closed displaced extra-articular metacarpal fractures, fractures treated using one of these two methods, displaced, rotated or angulated fractures, without any history of hand fractures on the same side, removing of the K-wires no longer than 8 weeks and the plates after at least 3 months, data regarding the number of recovering sessions, the Disabilities of the Arm, Shoulder and Hand (DASH) score and Total Active Motion (TAM) at two and twelve months was recorded, no complications were recorded except articular stiffness and extension lag, radiological proofs to confirm the diagnostic and the postoperative aspect of the reduced fractures.

Patients with open fractures after high-energy injuries were not included in the analysis because of the complex variables related to the soft-tissue lesions. The patients were divided in two groups: osteosynthesis using plates and screws (PS group) and osteosynthesis using K-wires (KW group). In the PS group, 2.0 mm or 2.5 mm locked or unlocked low profile compression plates and 2 mm or 1.7 mm screws were used. In order to install the plate, a small portion of the periosteum was removed in order to facilitate the contact between the bone and the plate in order to increase stability of the fracture site. In the KW group, the fractures were reduced using 1.5 mm or 1.1 mm K-wires which were placed in an intramedullary, crossed or bouquet manner (Figure 1). The surgical procedures were performed according to the AO methodology.



Figure 1.

The database included the following information: name, age and sex of the patient, admission and discharge date, the department of admission (Plastic or Orthopedic Surgery), the type of displacement and fracture (simple or comminuted), the affected part of the bone (shaft, neck or base), osteosynthesis method, number of recovery sessions, number of days of immobilization. The DASH and the TAM score were calculated after 2 and 12 months from the surgery in each group. The data were analyzed using Microsoft Office Excel 2016 and IBM SPSS Statistics 3. We used test of normality for the distribution of the data, Shapiro-Wilk, non-parametric Mann-Whitney test, Chi-square test, T Test, Levene test to assess the homogeneity of the variances, and the Pearson Correlation Test. Mainly, we assessed which of the osteosynthesis methods offers better functional results based on the DASH and TAM scores.

RESULTS

The results are summarized in Table 1. The DASH scores were lower (showing better results) in the PS group compared to the KW group, with a mean difference of 20.53 after two months (Figure 2) and 6.41 after twelve months (Figure 3) while the TAM scores were higher (235° at two and 261° at twelve months in the PS group compared with 218° at two and 257° at twelve months in the KW group) (Figure 4,5). The difference between the two groups regarding the TAM (Mann-Whitney U, U=197.5, z=-4.656, p<0.001 at 2 months,

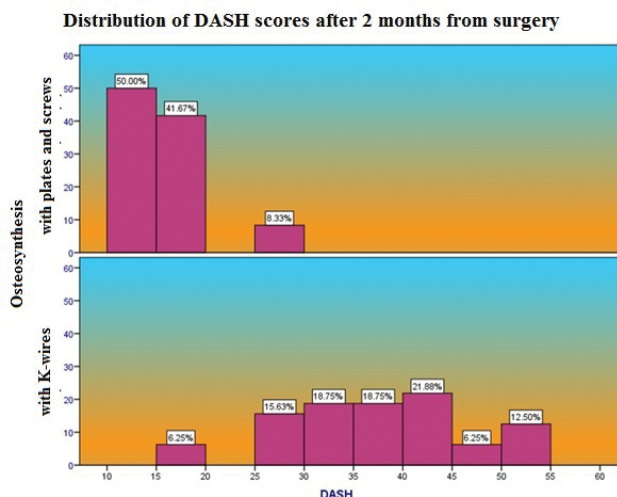


Figure 2.

t test forequal variances, p<0.001, 95% Confidence interval 2°-6° at 12 months) and DASH score (Mann Whitney U, U=23.5, z=-6.808, p<0.001 at 2, Mann-Whitney U, U=102, z=-5.842, p<0.001 at 12 months), was statistically significant. The associations between the number of days of immobilization and the DASH (positive correlation, Spearman r=0.644, p<0.001 at 2 months – Figure 6; r=0.543, p<0.001 at 12 months – Figure 7) and TAM (negative correlation, Spearman r=-458, p<0.001 at 2 months; r=-412, p<0.001 at 12 months – Figure 8), the number of immobilization days and the number of recovery sessions (positive correlation, Spearman r=0.521, p<0.001, Figure 9), were

Table 1. Summary of results

	Osteosynthesis using plates and screws – PS group (n=36)	Osteosynthesis using K-wires – KW group (n=32)
Mean Age (years)	30.41 (SD 10.46)	30.17 (SD 10.63)
Gender	9 female, 27 male	3 female, 29 male
Department of Plastic Surgery	6 patients	17 patients
Department of Orthopaedic Surgery	30 patients	15 patients
Fracture site		
Neck	n=5	n=6
Shaft	n=31	n=26
Number of metacarpals involved	one – n=30 two – n=5 four – n=1	one – n=27 two – n=5
Mean DASH score at 2 months	16.13 (SD 4.08)	36.66 (SD 9.1)
Mean TAM score at 2 months	235° (SD 11°); 33% values between 240-245°	218° (SD 18°); more than 25%, values between 230-235°
Mean DASH score at 12 months	3.88 (SD 4.11)	10.29 (SD 3.52)
Mean TAM score at 12 months	261° (SD 3°); 50% values between 260-265°	257° (SD 4°); 43%, values between 255-260°
Number of days of immobilization (mean value)	17 (SD 6.23)	28.44 (SD 7.41)
Number of recovery sessions (mean value)	16 (SD 4.4)	21 (SD 4.95)

*SD – standard deviation, *n = number of patients

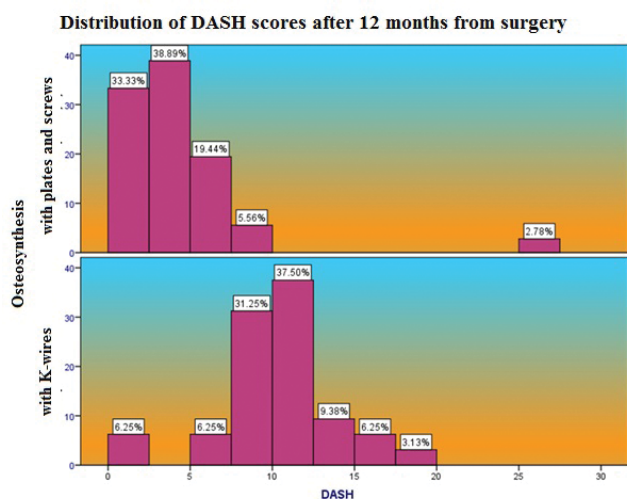


Figure 3.

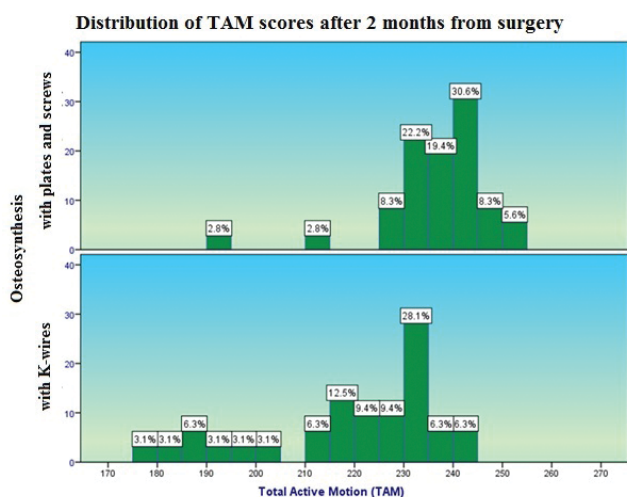


Figure 4.

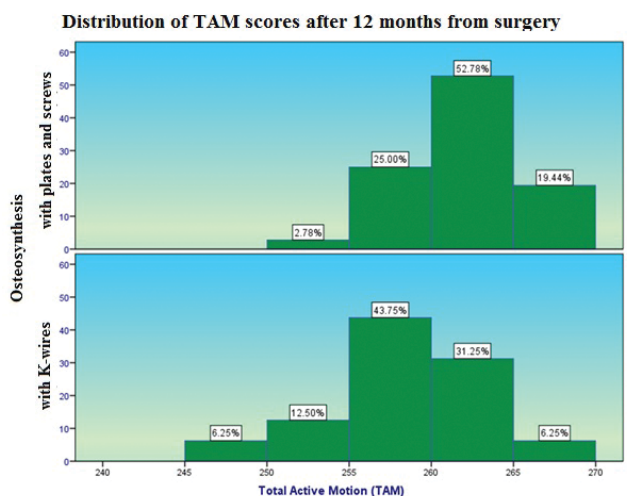


Figure 5.

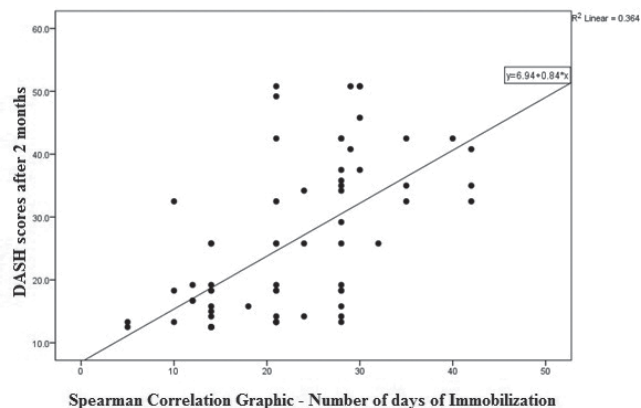


Figure 6.

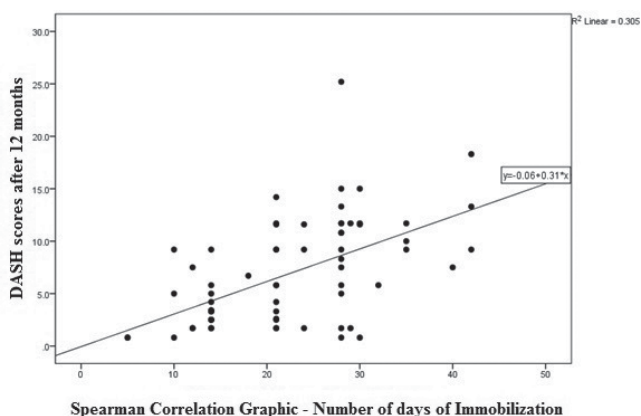


Figure 7.

statistically significant. Therefore, wearing a cast for a smaller period will lead to better functional results (lower DASH score and higher TAM score) with the necessity of a fewer recovery sessions. The following correlations between age, sex, side, fracture site and the type of osteosynthesis were statistically insignificant.

DISCUSSIONS AND CONCLUSIONS

After performing the data analysis, the postoperative evolution and recovery of the patients treated with plates and screws, compared to those treated with K-wires was better, as shown by the better DASH and TAM scores in the PS group. Therefore, using an osteosynthesis method that is less stable in order to preserve the periosteum (K-wire) is associated with poorer results compared to an osteosynthesis method that implies limited periosteum removal but offers greater stability of the fracture site (plates and screws).

Regarding the immobilization time, the patients in the PS group required a smaller amount with a mean of 17 days, more than 60% of them regaining function

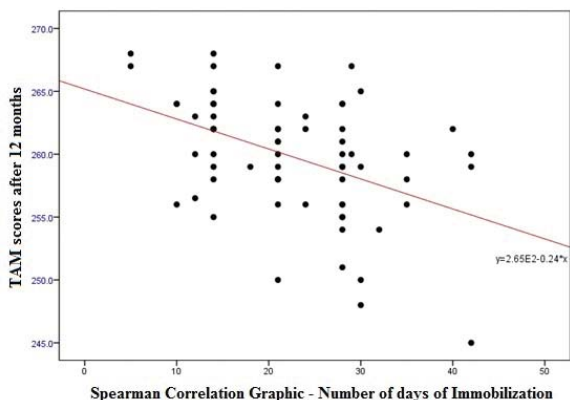


Figure 8.

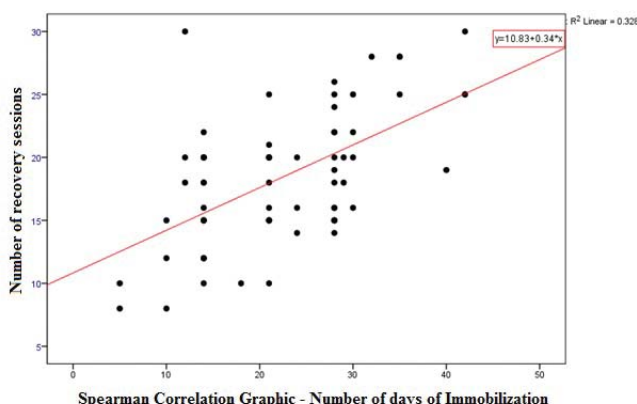


Figure 9.

after 20 days, while in the KW group, the mean time was 28 days, with regaining of the function soon after this period. Therefore, the number of recovery sessions was higher in the KW group due to the greater number of days of immobilization. Economically speaking, on the short term, using the plates and screws technique is more expensive than Kirschner wires, but on the long term, the KW group needed more days of recovery compared to the PS group which is associated with late professional reinsertion and higher costs for the employer and the National Health Insurance Company.

In the specialized literature, there are few comparative studies regarding this two osteosynthesis methods. Many of them are used in order to reduce fractures of the forearm, clavicle, tibia and metatarsals. In December 2008, Ozer et al. published¹ the first prospective study in order to compare osteosynthesis with low contact dynamic compression plates with intramedullary fixation using K-wire in order to treat metacarpal fractures. From a total of 52 patients, 14 were treated using plates and screws and the rest using K-wires. Statistically, there was no significant difference regarding the TAM and the DASH score between the two groups.

However, the groups had uneven number of patients and the randomization of the method was absent.

In this study, 8 presented fractures of the fifth metacarpal neck of which 3 were reduced using plates and screws and the rest using K-wires. The mean value of the TAM score for those within the KW group was 254°, while in the other group was 260°, showing better results where plates and screws were used. However, a clinical study on 38 closed neck fifth metacarpal fractures published by Facca et al.² showed no significant difference between the TAM values recorded in each group in order to compare T-shaped plate with intramedullary K-wire.

According to recent studies, using plates and screws in order to reduce metacarpal fractures, up to 36% of the patients have complication, of which, stiffness is the most common (76% of the patients with complications) and it is associated with a TAM value smaller than 220°^{3,4}. In this study, a significant loss of function was associated with a TAM score smaller than 240° which was encountered in 56% of the patients where plates and screws were used. However, after recovery sessions, at 12 months, all of the patient had greater values than 240°. Our results are different from those reported in the specialized literature due to the absence of recent studies regarding different osteosynthesis materials with low profile and high stiffness in order to treat hand fractures. Unlike other fracture sites where plates which occupies a larger volume could be used, for the hand fractures it is important to use thin plates. In a recent study regarding absorbable plates used in order to treat metacarpal fractures of 12 patients, the results were satisfying with a mean of TAM score of 234°⁵, taking into account the absorption process that could lead to tendon adhesions and extension lag. In our study, low profile plates with round or oval holes were used, perfectly shaped in order to fit to the metacarpal curves and to reduce the impact on the extensor tendons⁶.

To gain strength, the bone should be dynamically loaded because in order for a fracture to heal the absence of the bone continuity must be felt. Ilizarov proved the importance of dynamic loads transmitted in the axial direction for posttraumatic osteogenesis⁷. However, in hand bones, the axial load is not as important as resistance to flexion, torsion and shear. The thin profile of plates, as well as the materials are made of, allow the existence of micro movements at the fracture site being more rigid than the others, but keeping a minimum degree of elasticity. Designing a plate which allows micro-movements at the fracture site in order to mimic a healing closer to the biological one would be ideal.

In this study we compared two osteosynthesis methods, one that involves preserving the periosteum (KW) and one that involves a limited area of periosteum to be removed (PS). The results in the PS were better, thus limited periosteum removal do not influence significantly the functional outcomes. Nowadays, the periosteum shows increasingly more interest in bioengineering studies, due to the presence of cambium which, under some stimuli, is able to offer a substantial source of stem cells, especially chondrocytes precursors^{8,9}. Therefore, the periosteum grafts can be used to reconstruct the articular cartilage¹⁰, in autologous chondrocytes transplantation¹¹, in non-union fracture treatment¹², in restoring patellar joint¹³ or in bone transplant obtained by bioengineering for maxillary sinus augmentation¹⁴. According to our study, healing of the metacarpal fracture reduced using plate and

screws is possible, with great results even in the absence of a part of the periosteum corresponding to the area of osteosynthesis material. Thereby, the tubular bones of the hand might be genuine sources of periosteum with utility in regenerative medicine, easily harvested and with minimal comorbidities.

In conclusion, our study has shown the superiority of the functional results after osteosynthesis using plates and screws in order to treat metacarpal fractures despite limited periosteum removal, compared to Kirschner wire fixation, where to periosteum was preserved. The development of a prospective study protocol, could provide information of interest regarding the treatment of hand fractures and the effects of periosteum removal, in order to establish the best option according to the configuration of the fracture.

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