ISSN 0009-479X

Chir. Narzadow Ruchu Ortop. Pol., 2020; 85(1-2) 6-10
DOI: 10.31139/chnriop.2020.85.1-2.2

ORIGINAL PAPER

# Evaluating outcomes of surgical treatment of patients with degenerative changes in the carpometacarpal joint of the thumb using percutaneous stabilization with Herbert screws and Reg-Joint implants – a pilot study

## Ocena wyników leczenia operacyjnego pacjentów ze zmianami zwyrodnieniowymi stawu nadgarstkowo-śródręcznego kciuka przy użyciu przezskórnej stabilizacji śrubami Herberta oraz implantów Reg-Joint – badanie pilotażowe

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### Abstract

Based on a review of the current literature, different approaches are observed to treat degenerative changes within the carpometacarpal joint (CMC) of the thumb. The primary purpose of treating this type of condition is to relieve pain and also to obtain (restore) the best possible function of the thumb. Meeting these conditions ensures a minimum operative approach and the shortest possible immobilization of the upper limb. This promotes early, active rehabilitation. The choice of optimal treatment still seems to be debatable, depending on: the degree of damage to the CMC (the extent of radiological changes), degree of severity of clinical symptoms, patient's age, patient's expectations and finally the duration of the treatment. The study material included 30 patients treated in the Department of Trauma and Orthopedic Surgery at L. Rydygier District Hospital in Brzesk. All patients were randomly assigned to one of two groups. Group 1 was treated with a closed reduction and percutaneous stabilization with 2 Herbert screws. Group 2 was treated using arthrotomy and Reg-Joint implants. The following research tools were used to evaluate outcomes of the treatment: VAS for pain, assessment of the quality of life and functional performance of the limb based on the Quick DASH questionnaire, assessment of the overall hand-grip strength with SAEHAN hydraulic dynamometer, assessment of the frequency of complications. No differences in treatment outcomes were observed as regards both methods 3 months after the surgery. After 6 months of follow-up observation, better treatment outcomes were obtained with the Reg-Joint implants. Using the Reg-Joint implant is more likely to result in: less pain, better limb performance, better quality of life, and higher values for hand-grip strength. The frequency of postoperative complications is similar for both methods.

**Key words:** surgical treatment, carpometacarpal joint of the thumb, Reg-Joint, Herbert screws

### Streszczenie

Na podstawie przeglądu aktualnej literatury obserwuje się różne koncepcje leczenia zmian zwyrodnieniowych w obrębie stawu śródręczno-nadgartskowego kciuka (CMC). Podstawowym celem leczenia tego typu schorzeń jest uzyskanie zniesienia bólu, a jednocześnie uzyskanie (powrót) jak najlepszej funkcji kciuka. Spełnienie tych warunków gwarantuje minimalny dostęp operacyjny oraz możliwie jak najkrótsze unieruchomienie operowanej kończyny górnej. Daje to możliwość prowadzenia wczesnego, aktywnego usprawniania. Nadal dyskusyjny wydaje się być wybór optymalnych zasad leczenia w zależności od: stopnia uszkodzenia stawu CMC (zaawansowania zmian radiologicznych), stopnia nasilenia objawów klinicznych, wieku chorego, jego oczekiwań czy w końcu czasu interwencji. Materiał badany obejmował 30 chorych leczonych operacyjnie w Oddziale Chirurgii Urazowo-Ortopedycznej Szpitala Powiatowego im. L. Rydygiera w Brzesku. Wszyscy chorzy przydzieleni zostali losowo do jednej z dwóch grup. Grupa 1 leczona była metodą zamkniętej repozycji i przezskórnej stabilizacji 2 śrubami Herberta. Grupa 2 operowana została metodą artrotomi i implantacji Reg-Joint. Do oceny wyników leczenia wykorzystano następujące narzędzia badawcze: ocena natężenia bólu w skali VAS, ocena jakości życia i sprawności funkcjonalnej kończyny w oparciu o kwestionariusz Quick DASH, ocena siły chwytu globalnego przy pomocy dynamometru hydraulicznego SAEHAN, ocena częstości powikłań. Nie zaobserwowano różnic w wynikach leczenia w obu metodach po 3 miesiącach od zabiegu. Po 6 miesiącach obserwacji lepsze wyniki leczenia uzyskano w metodzie z implantacja Reg-Joint. Zastosowanie implantu Reg-Joint predysponuje do uzyskania: mniejszego natężenia bólu, lepszej sprawności kończyny, wyższej jakości życia oraz wyższych wartości siły chwytu. Częstość występowania powikłań pooperacyjnych jest zbliżona w obu metodach.

**Słowa kluczowe:** leczenie operacyjne, staw nadgarstkowo-śródręczny kciuka, Reg-Joint , śruby Herberta

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Received: **25.03.2020**
Accepted: **01.04.2020**
Published: **30.04.2020**

## Introduction

The first carpal-metatarsal joint (CMC) arthritis is the most common degenerative disease in hand joints. It mainly affects women between 50 and 70 years of age, accounting for 70 to 80% of patients treated for this condition [1]. It is assumed that the degenerative changes in CMC 1 (articulatio carpometacarpal) account for 10% of all degenerative changes affecting human joints [2]. Arthritis, or the alternative term osteoarthritis, is a non-inflammatory joint disease. At first, the regeneration of the articular cartilage is distorted which leads to its wear and damage. A secondary inflammation and progressive deformation and destruction of the joint occur [2,3]. Based on a review of current literature, different approaches are observed to treat degenerative changes within the carpometacarpal joint (CMC) of the thumb. The first traditional method is conservative treatment, which involves the immobilization of the upper limb in a cast or fixation orthosis. This method of treatment is always combined with physical therapy which aims to eliminate pain and improve the function of the thumb. Another method used to treat this pathology involves intra-articular injections of glucocorticoids and/or insulated collagen proteins [1,3]. If degenerative changes are more advanced or the previous treatment does not yield the desired effect, then the surgical treatment becomes the gold standard [1,2]. There are a number of operative methods and techniques used to treat CMC arthritis of the thumb. The main treatment methods include percutaneous arthrodesis using a fixation hardware (Kirschner pins, cannulated screws, compression screws, staples); arthrotomy with fragment removal (subtotal trapeziectomy) or removal of the whole trapezium (total trapeziectomy) combined with tendinoplasties within the wrist (FCR, APL), implantation of Reg-Joint into CMC 1. An increasingly widespread method of treatment of degenerative changes of the CMC is the implantation of prostheses in this joint (more often cemented ones and occasionally cement-free) [2, 3, 4, 5, 6, 7].

The primary purpose of treating this type of condition is to relieve pain and also to obtain (restore) the best function of the thumb. Meeting these conditions ensures a minimum operative approach and the shortest possible immobilization of the upper limb. This promotes early, active rehabilitation. The choice of optimal treatment principles still seems to be debatable, depending on: the degree of damage to the CMC (the extent of radiological changes), degree of severity of clinical symptoms, patient's age, patient's expectations and finally the duration of the treatment[1, 4, 5]. A key problem is the choice of a golden mean to follow the above-mentioned elements of treatment optimization for this type of disease. We are facing a situation similar to our predecessors - we have a number of good therapeutic and surgical solutions to choose from, but there is often no convincing scientific evidence of the superiority of one treatment method over others [1, 3, 8].

The aim of this study was to compare outcomes of surgical treatment of patients with degenerative changes in the carpometacarpal joint of the thumb treated with percutaneous stabilization using Herbert screws and Reg-Joint implants.

## Material and Methods

The study material included 30 patients treated in the Department of Trauma and Orthopedic Surgery at L. Rydygier District Hospital in Brzesk in 2019. The study group included 21 women and 9 men aged between 32 and 73 (mean = 52.2 years). All patients were randomly assigned to one of two groups. Each group consisted of 15 patients. Group 1 was treated with a closed reduction and percutaneous stabilization with 2 Herbert screws. The mean age of patients in this group was 62.5 years. Group 2 was treated using arthrotomy and Reg-Joint implants. The mean age of patients in this group was 49 years

The operative technique was stabilization with Herbert screws. After prior preparation, the limb was reduced. The reduction was performed using thumb traction to remove the CMC subluxations. Under C-arm guidance, 2 Kirschner wires were inserted percutaneously from the dorsal part of the first metacarpal to the trapezium. Using a dedicated drill guided on the "fixated" Kirschner wires, a site has been prepared to insert the screws. Two Herbert screws were inserted along the Kirschner wires. After the surgery, full cast immobilization was used for 6 weeks.

Operative technique - Reg-Joint implants to the CMC joint. Dorsal approach between the following tendons was used: the extensor pollicis longus (EPL) and the abductor pollicis longus (APL). After reaching the CMC joint of the thumb, the articular surface, the bone build-up of osteophytes of the first metacarpal bone, and a fragment of the trapezium of the affected joint were very sparingly removed. Following the resection of all the affected tissues, Reg-Joint was implanted (Fig. 1). Under X-ray guidance, the optimal position of the prosthesis has been confirmed in AP and lateral projections. After the procedure, a figure-of-8 splint was used for 6 weeks for immobilization.

The following research tools were used to evaluate the outcomes of the treatment:

- assessment of pain on a VAS for pain,
- assessment of the quality of life and functional performance of the limb based on Quick DASH (Disability of Arm Shoulder and Hand Questionnaire),
- assessment of the overall hand-grip with SAEHAN hydraulic dynamometer,
- assessment of the frequency of complications.

The parameters described were evaluated 3 and 6 months after surgery.

Fig. 1. Reg-Joint implant (own material).

The description of the data for the entire study group was compiled using the basic statistical parameters: median (Me), lower and upper quartiles Q25 and Q75. The analysis uses the chi-square ($\chi 2$) test, the Mann-Whitney test.

## Results

The evaluation of treatment outcomes 3 months after surgery did not reveal statistically significant differences in pain intensity, quality of life and functional performance of the upper limb and the magnitude of the overall hand-grip strength between the two treatments. The significance level of the Mann-Whitney test was p>0.05 (Tab. 1).

Table 1. Comparison of treatment outcomes in both groups after 3 months of treatment.

| Evaluated parameter | The significance level of the Mann-Whitney test |
|---|---|
| Pain intensity on VAS | NS |
| Quality of life on a DASH scale | NS |
| Overall hand-grip strength | NS |

A comparison of the treatment outcomes in both groups after 6 months showed that patients treated with percutaneous stabilization with Herbert screws had higher pain intensity than patients treated with Reg-Joint. The observed difference between the groups was statistically significant. The significance level of the Mann-Whitney test was p< 0.05 (Tab. 2).

Table 2. Pain intensity on VAS in both groups after 6 months of treatment.

| VAS 6th month | Median | Q25 - Q75 | Min | Max |
|---|---|---|---|---|
| Herbert screws | 3.0 | 1.0-3.0 | 1.0 | 8.0 |
| Reg-Joint | 1.0 | 1.0-2.0 | 0.0 | 4.0 |
| The significance level of the Mann-Whitney test | | p< 0.05 | | |

Patients treated with Herbert screws had a lower quality of life and limb performance compared to the group treated with Reg-Joint. The median in the first group of patients reached 22.7 and in the second group 4.5. The recorded difference between the groups was statistically significant was reflected in the significance level of the Mann-Whitney test p<0.05 (Tab. 3).

Table 3. The quality of life and limb performance measured using the DASH questionnaire in both groups after 6 months of treatment

| DASH symptoms | Median | Q25-Q75 | Min | Max |
|---|---|---|---|---|
| Herbert screws | 22.7 | 15.9-43.2 | 6.8 | 81.8 |
| Reg-Joint | 4.5 | 0.0-11.4 | 0.0 | 36.4 |
| The significance level of the Mann-Whitney test | | p< 0.05 | | |

The average hand-grip in the 6th month after treatment, measured with the median value, has reached: 12.0 in the group treated with Herbert screws and 25.0 in patients treated with Reg-Joint. The recorded difference was statistically significant. The Mann-Whitney test was p< 0.05 (Tab. 4).

Table 4. Hand grip in both groups after 6 months of treatment.

| \|Hand-grip strength 6th month | Median | Q25-Q75 | Min | Max |
|---|---|---|---|---|
| Herbert screws | 12.0 | 4.0-18.0 | 0.0 | 38.0 |
| Reg-Joint | 25.0 | 18.0-33.0 | 8.0 | 53.0 |
| The significance level of the Mann-Whitney test | | p< 0.05 | | |

A similar number of complications were observed in patients treated with both methods. The frequency of postoperative complications in the patient group after percutaneous stabilization with Herbert screws after 3 months was 7 % (1 patient). 1 Herbert screw broke in this patient. In the group of patients after Reg-Joint implants, after 3 months, 1 complication was also observed, amounting to 7 %. The female patient experiences a prolonged postoperative wound healing, which at the same time required a prolonged antibiotic therapy (bacterial cultures were negative). 6 months after the surgery, no complications were observed in both groups. There were no statistically significant differences between the groups (Tab. 5).

Table 5. Comparison of the frequency of postoperative complications in both groups of patients.

| Postoperative complications | The significance level of $\chi^2$ (assessment of the significance of the variable variation in both groups) |
|---|---|
| After 3 months | NS |
| After 6 months | NS |

## Discussion

There is no clear scientific evidence in the literature as to which treatment method is "better". Often, the results of studies that only examine one treatment method are not sufficient to confirm the superiority of the method over the other treatment methods used so far. This study directly compares two common methods of surgical treatment factoring in: hand performance, quality of life and postoperative complications. An attempt to compare treatment results using percutaneous stabilization with Herbert screws and with Reg-Joint confirmed that there were statistically significant differences as regards the overall hand-grip strength after Reg-Joint implant in the 6th month after the procedure. Different results are reported by Tiihonen R et al. [13] who did not confirm statistically significant differences in hand-grip strength values in both groups. Ikävalko M et al. [11 ] report that the hand-grip strength was higher in the group treated with a Reg-Joint implant in CMC 1. The observed difference occurred after 12 months of follow-up observation. The follow-up study carried out 3 and 6 months after the procedure did not confirm the presence of differences between the groups. Honkanen, P.B. and al. [10] report that in the group of 50 patients treated with percutaneous stabilization with Herbert screws, they did not observe statistically significant differences in the value of the overall hand-grip strength in the healthy and operated hand. On this basis, it can be concluded that the hand-grip strength in the operated hand returns to normal. The results obtained in our group do not support these observations. Mattila et al. [14] in treating 25 patients with Herbert screws, obtained an overall hand-grip strength of 81% in relation to a healthy hand after 24 months. An important remark was made about the hand-grip strength by Mattila et al. [15] who believe that the grip strength of patients treated with both methods is similar in the 2nd and 4th month of observation.

Our study has shown that patients treated with Reg-Joint implants have better limb performance, better quality of life, and less pain after treatment. Mattila et al. [15] confirmed that patients treated with percutaneous stabilization with Herbert screws may start rehabilitation sooner and perform daily activities sooner. However, this does not translate into the final final treatment outcome. Most patients treated with Reg-Joint (80%) returned to work after 6 months, while in the case of percutaneous stabilization method only 35% of patient returned to work. Tiihonen et al. [7] reported on a study involving percutaneous stabilization of the CMC joint with Herbert screws in 33 patients. In the opinion of the authors, the method used enables early mobilization and faster resumption of hand function. For comparison, Honkanen and al. [9] did not observe statistically significant differences in the number of points scored in the DASH questionnaire between the treatment group using Herbert screws and Reg-Joint. Mattila et al. [15] have also reported, as we have, that patients who were treated with Reg-Joint scored more points in DASH compared to patients treated with percutaneous stabilization with Herbert screws after 6 months of observation. Van Royen K et al. [17] provided a meta-analysis of a large group of patients whose degenerative changes in the CMC were treated surgically with percutaneous stabilization using 2 Herbert screws. The authors report better results in a DASH questionnaire in the 3rd month in a group treated with Herbert screws compared to a group treated with Reg-Joint implant. This group achieved an average score of 7.5 points. After 6 and 12 months the difference between the groups fell to 3.8 points. Summing up their study, Tiihonen et al. [6] conclude that statistically better functional results can be expected for Reg-Joint treatment. This method of treatment contributes to patient's faster resumption of daily activities. Matilla and Waris [16] have studied a large group of patients aged 18-70 with degenerative changes in the CMC of thumb and Reg-Joint implants. They claimed that these patients made faster progress in rehabilitation when treatment involved this type of implant.

In our study, we did not evaluate the range of thumb movements. However, on the basis of a statistically proven improvement in hand performance in the Reg-Joint method, it can be assumed that the range of motion is also better for this method. Similar results are reported by Ikävalko et al. [11] who confirmed that the CMC movement range in the group treated with Reg-Joint was statistically higher than in the group treated with percutaneous stabilization with Herbert screws. Mattila et al. [15] also report that the flexion and extension in the group treated with Reg-Joint reaches higher values after 6 months. Waris E et al. [16] in treating a group of patients using Herbert screws, obtained, in a follow-up study

after 30 months, an average hand movement range of 95% in relation to a healthy hand. Tiihonen et al. [7] report that in the group of 54 patients treated with Herbert screws, they did not observe statistically significant differences in the value of wrist movement in healthy and operated hand. Honkanen et al. [9] confirmed that patients treated with the Reg-Joint method had a better CMC stabilization and better chance of earlier rehabilitation and greater range of motion. Honkanen et al. [10] report that the range of movements in patient treated with both methods is similar in both methods when the correct radiological parameters are reproduced. The greatest loss was observed in the thumb circumduction.

Tiihonen et al. [6] observed significantly fewer complications in post-operative wound healing in a group treated with percutaneous stabilization (no skin necrosis and delayed wound healing were observed). Our studies did not reveal any significant differences in the frequency of postoperative complications, including problems with wound healing. Similar observations are reported by Mattila et al. [15] who did not confirm a statistically significant difference as regards the risk of other listed complications, i.e. deep wound infections, neurological defects, tendon damage, resurgery. Van Royen K et al. [17] when treating 50 patients with Reg-Joint, reported as many as 16% of the complications, the most common of which were: loosening of the implant and a prolonged healing of the postoperative wound. However, this did not translate into generally satisfactory treatment outcomes.

## Conclusions

1. No differences in treatment outcomes were observed as regards both methods 3 months after surgery.
2. After 6 months of follow-up observation, better treatment outcomes were obtained with the Reg-Joint implants.
3. Using the Reg-Joint implant is more likely to result in: less pain, better limb performance, better quality of life, and higher values for hand-grip strength.
4. The frequency of postoperative complications is similar for both methods.

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