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Original Article

Rheumatic hand's clinical, functional and imagiological correlations following metacarpophalangeal joint silicone arthroplasty☆

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ABSTRACT

Objective: Evaluation of rheumatoid hand-associated metacarpophalangeal joint silicone arthroplasty most often relies on functional scores alone. This study aimed to understand the correlation between perceived and observed function, strength, and alignment.
Methods: Cross-sectional study including all 11 women (15 hands) submitted to second to fifth metacarpophalangeal joint arthroplasty due to rheumatoid arthritis involvement for a time period of seven years. Measurements relied on the Michigan Hand Outcomes Questionnaire, Lafayette Purdue Pegboard, pinch and grip strength, and analysis of a lateral "OK-sign" X-ray view. Correlation analysis used Spearman's coefficient, assuming statistical significance for p-values < 0.05.
Results: Objective function was strongly correlated with all other variables ($p < 0.05$), while perceived function failed to correlate with articular alignment in both measurements ($p = 0.240$ and $p = 0.354$). Strength and alignment were also strongly correlated ($p < 0.05$).
Conclusions: Most measurements strongly correlate with each other, with emphasis on objective dexterity measurement.

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Correlações clínicas, funcionais e imagiológicas após artroplastia da articulação metacarpofalangiana com implante de silicone na mão reumatóide

Palavras-chave:
Artrite reumatoide
Artroplastia
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Força da mão
Silicones

RESUMO

Objetivo: Na maioria das vezes, a avaliação da artroplastia da articulação metacarpofalangeana com implante de silicone é feita apenas por meio de escores funcionais. Este estudo teve como objetivo compreender a correlação entre função, força e alinhamento percebidos e observados.

Métodos: Este estudo transversal incluiu todas as 11 mulheres (15 mãos) que foram submetidas a artroplastia metacarpofalangeana no segundo ao quinto dedo devido a artrite reumatoide em um período de sete anos. As medições basearam-se no Michigan Hand Outcomes Questionnaire, no Lafayette Purdue Pegboard e nas forças de pinça e preensão, além da análise de radiografia da mão em leque. O coeficiente de Spearman foi usado para avaliar a correlação; valores de $p < 0,05$ foram considerados estatisticamente significantes.

Resultados: A função objetiva foi fortemente correlacionada a todas as outras variáveis ($p < 0,05$). Por outro lado, a função percebida não foi correlacionada ao alinhamento articular em ambas as medições ($p = 0,240$ e $p = 0,354$). A força e o alinhamento também estiveram fortemente correlacionados ($p < 0,05$).

Conclusões: A maioria das medições se correlacionou fortemente entre si, com ênfase na medição objetiva da destreza.

Introduction

Rheumatoid arthritis (RA), a chronic, systemic, T cell-driven autoimmune disease, is widely known for its repercussions in the hand, particularly in the middle-aged woman.[1] Early and severe involvement of the metacarpophalangeal (MCP) and interphalangeal joints leads to the nearly pathognomonic hand deformity composed by subluxation of the former and ulnar deviation of the fingers.[2] After initial efforts in controlling the disease through a conservative approach, late stages of the disease frequently require surgical intervention in order to restore hand alignment. Silicone MCP arthroplasty (SMPA), popularized by Swanson nearly 50 years ago, relies on the reactive encapsulation of the prosthesis.[3] By raising the MCP joint arc of motion, it aims to improve function and aesthetics, while attaining pain relief.[4,5] Arc of motion measurements have already proven themselves as a reliable method to approach patient satisfaction. However, despite this and other objective techniques, postoperative evaluation most often relies on perceived function scoring, notably using Michigan Hand Outcomes' Questionnaire (MHQ), as well as pinch and grip strengths.[5] Radiological finger alignment, as an example, has been scarcely used.[5] To our knowledge, however, objective hand dexterity has not so far been evaluated for the post-operative rheumatoid hand. The goal of our study was to determine the relevance of hand dexterity measurement as an objective approach to evaluate postoperative results of SMPA.

Materials and methods

We performed a cross-sectional study including all 11 patients submitted to 2nd to 5th MCP joint silicone arthroplasty using the Neuflex MCP prosthesis (Depuy Synthes, Warsaw, IN, USA) due to local involvement of rheumatoid arthritis, between July 1st, 2008 and June 30th, 2015. This gave us a convenience sample of 15 hands, four of which were non-dominant. All patients were women, with a median age of 67.0 years-old (interquartile range: 12.63) and a follow-up time of 30.0 months (interquartile range: 32.43). Perceived hand function was evaluated by MHQ, without medical surveillance, with strict help only in situations of doubt, aiming for lowering answering bias. MHQ comprises 37 outcome questions for each hand, on its function, its influence on daily routine and work, related pain, aesthetics and patient satisfaction, scoring from 0 to 100. Objective function measurement relied on Purdue Pegboard's test (Lafayette Instrument Co, Lafayette, IN, USA), in an adaptation of two of its four designed exercises. After an adaptation tryout, patients performed the first exercise, modified from the original, in which the measured hand was the one already submitted to surgery, consisting of sequential pin placement in a predefined board for a time period of 30 s (in the original form, both dominant and nondominant hands are measured for the first and second exercises). Each pin correctly placed counted as a point. The second exercise consisted on a 60-s run in which the patient had to assemble a pin-washer-collar-washer structure in a sequential manner, using both hands. Each piece applied counted as a point. Tip-pinch and grip strengths, measured in kilograms-force, were gathered calculating the mean of 5-tryout measurements, using a Jamar hydraulic pinch gauge and a Jamar hydraulic hand dynamometer (Lafayette Instrument Co, Lafayette, IN, USA). Lastly, dexterity-related finger alignment was measured on a lateral "OK-sign" X-ray view, consisting on the angle formed by the distal phalanx of both the thumb and the index finger (D1–2α), as well as the index

Fig. 1 – Determination of the angle formed by the distal phalanx of both the thumb and the index finger (D1–2α), in a lateral "OK sign" side X-ray.

Fig. 2 – Determination of the index formed by the minor (a) over major (b) diameters of the ellipse formed by the first and second fingers, in a lateral "OK sign" side X-ray.

formed by the minor over major diameters of the ellipse formed by the first and second fingers (Figs. 1 and 2). Due to our small sample size, correlation analysis had to rely on a non-parametric test, thus the choice for Spearman's coefficients. Statistical significance was considered whenever we found a *p*-value under 0.05. Analysis was performed using IBM SPSS Statistics v20.0.0 (IBM Corporation, Armonk, NY, USA).

Results

Table 1 summarizes the descriptive data. It is noteworthy to mention high interquartile ranges for most measured variables, in compliance with highly different surgical outcomes. Subjective function, as measured by MHQ, revealed statistically significant correlations with objective function, as measured by PP's affected hand (rho = 0.702; $p = 0.004$) and assembly scores (rho = 0.521; $p = 0.047$), and also with tip-pinch strength (rho = 0.746; $p < 0.001$). Neither grip strength (rho = 0.298; $p = 0.280$) nor X-ray alignment as measured by D1–2α (rho = −0.323; $p = 0.240$) and minor over major elliptical diameter index (rho = −0.257; $p = 0.354$) found the same. Apart from subjective function, as mentioned above, objective function measurement in its assembly score also correlated with all other variables in a statistically significant fashion (key-pinch strength: rho = 0.850, $p < 0.001$; grip strength: rho = 0.677, $p = 0.006$; D1–2α: rho = −0.543, $p = 0.037$; minor over major elliptical diameter index: rho = −0.619, $p = 0.014$). The affected hand score solely correlated with key-pinch strength (rho = 0.659; $p = 0.008$), apart with the assembly score (rho = 0.675; $p = 0.006$) and MHQ. Alignment (both the first-second finger distal phalanx angle and minor over major elliptical diameter index) was also statistically significantly correlated with both pinch (rho = −0.798; $p < 0.001$ and rho = −0.720; $p = 0.002$, respectively) and grip strengths (rho = −0.798; $p < 0.001$ and rho = −0.720; $p = 0.002$). This is summarized in Table 2.

Discussion

Synovitis of the MCP joint ends up in its ulnar deviation and volar joint subluxation caused by changes in the volar plate and ligamentous support. This also leads to shortening of the intrinsic muscles and consequent proximal interphalangeal joint hyperextension, aggravated by long extensor tendon attachment changes at the proximal phalanx.[4] All this may pose difficulties in hand function, mainly on strength and dexterity, lastly leading to a decrease in patient's satisfaction. In

Table 1 – Collected measurement data regarding perceived (MHQ) and objective (PP) functions, strength (key-pinch and grip) and alignment (through X-ray measurements).

	Median	P_{25}–P_{75}
A. Michigan Hand Outcomes Questionnaire (%)	21.00	48.00
1. General score	41.18	43.64
2. Work score	25.00	55.00
3. Pain score	25.00	65.00
4. Appearance score	12.50	32.25
5. Final questions score	5.17	70.83
B. Purdue Pegboard dexterity test (points)		
1. Affected hand score (30 s)	10	6
2. Assembly score (60 s)	15	10
C. Strength (KgF)		
1. Tip-pinch	3.00	1.50
2. Grip	5.00	4.00
D. X-ray measurements		
1. Distal phalanx D1–D2 angle (°)	91.0	70.8
2. D1–D2 ellipse: minor over major diameter index	0.55	0.20

a way to solve it, SMPA has already proven itself effective, considering properly selected patients.[6] A high focus relies on meeting patients' expectations, thus rendering it important to understand what, on objective terms, is understood as such.[7] In our trial, the existence of strong relationships between most of the measured variables strongly suggests their validity in measuring success following SMPA. This is not surprising considering hand function depends on its strength and proper joint alignment. What ends up as surprise is the major utility of hand dexterity measurements when compared with MHQ. It is more relatable and, therefore, more universal and most likely less prone to bias. When comparing pre with postoperative patient satisfaction, regarding SMPA, it has already been found that it is not directly related with pinch and grip strength but rather to improvements in alignment and arc of motion.[3,5,7] Postoperative satisfaction per se, on any given moment, was not yet analyzed, to our knowledge. As a surrogate measurement, arc of motion does not also directly reflect function, as it does not measure the major benefits coming out of it. Hand dexterity measurements, on the other hand, are widely used in industrial and medical purposes with interesting results.[8] An apparent benefit coming out from regular hand practice, despite influences originating on hand size and age, has already been reported.[8] As a cross sectional study, it is limited by readings performed at different follow-up times at different ages. Although not directly affecting the observed correlation between measurements, it has already been observed that hand function, as a whole, declines over time, lastly resulting in implant failure.[9–11] This is of major concern when designing new implants, as RA is punishing not only joint surfaces but also capsular and tendinous structures. The main goal is to allow for encapsulation, in order to reach stability, at the same time proper alignment and function are achieved. Silicone implants rely their movement on a central hinge, which cannot be either too thin, for resistance purposes, nor too thick, for flexibility purposes.[12,13] The implant itself is not designed to a specific patient leading to variable results, with complication rates varying from study to study, with ours in between.[11,13,14] As strength seems not to be of major concern in regards of perceived and objectified function, and although none of our patients had failed implants or was submitted to revision surgery, it may be of interest to design prosthesis better related to durability, although failed implants seem not to be correlated with patient satisfaction.[5,9,14] Assembly scores on dexterity measurement requires both hands, which may pose biased results as some patients were submitted to bilateral surgeries while the majority was not. Anyhow, this did not disturb correlation analysis, possibly because their disease was already more severe in regards of joint involvement. The small sample size is related to the reasonably small population undergoing complete second to fifth SMPA in our institution, possibly due to the increasing success of non-surgical approaches when dealing with RA. We also failed in not directly surveying for pain, either it being constant or recurrent, relying on the MHQ alone, although it could come as a major independent factor relating to patients' satisfaction.[15] All added, and comparing to what's been discovered so far in regards of surgical success, our study is important in suggesting dexterity tests as major players in measuring objective function.[5] This may be futurely

Table 2 – Correlation analysis of the different variables using Spearman's test.

Spearman's correlation "*rho*" (*p*-value)	A. MHQ	B.1. PPAHS	B.2. PPAS	C.1. Pinch S.	C.2. Grip S.	D.1. X-ray D1–2α	D.2. X-ray ellipse
A. MHQ	1.000	0.702 (0.004)	0.521 (0.047)	0.746 (<0.001)	0.298 (0.280)	−0.323 (0.240)	−0.257 (0.354)
B.1. PPAHS		1.000	0.675 (0.006)	0.659 (0.008)	0.191 (0.496)	−0.148 (0.598)	−0.076 (0.789)
B.2. PPAS			1.000	0.850 (<0.001)	0.677 (0.006)	−0.543 (0.037)	−0.619 (0.014)
C.1. Pinch S.				1.000	0.643 (0.010)	−0.627 (<0.001)	−0.581 (0.002)
C.2. Grip S.					1.000	−0.798 (<0.001)	−0.720 (0.002)
D.1. X-ray D1–2α						1.000	0.533 (0.041)
D.2. X-ray ellipse							1.000

MHQ, Michigan Hand Outcomes Questionnaire, total score; PPAHS, Purdue Pegboard's test affected hand score; PPAS, Purdue Pegboard's test assembly score; Pinch S., key pinch strength; Grip S., grip strength; X-ray D1–2α, Thumb-index finger distal phalanx "OK-sign" side angle; X-ray ellipse, index of minor over major elliptical diameter formed by the "OK-sign".

tested in a pre to postoperative analysis, in order to improve both implants and techniques related to the rheumatoid hand. Obviously such should be always correlated with quality of life assessment surveys, as there may be a limit in which function does not necessarily result in general patient satisfaction.[16,17]

Conclusions

Summarizing, hand dexterity as measured by Purdue Pegboard's test offers a relatable and reliable approach to objectively measure the outcome of patients with rheumatoid hand submitted to SMPA. Alignment and strength also correlated strongly, thus pointing out the relevance of proper arthroplasty positioning during the procedure.

Conflicts of interest

The authors declare no conflicts of interest.

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