

RESEARCH ARTICLE

Structural damage of the hand in hand osteoarthritis: impact on function, pain, and satisfaction

Zvekić Svorcan J¹, Minaković I², Krasnik R¹, Mikić D³, Mikov J⁴, Stamenković B⁵

¹Department of Medical Rehabilitation

²Department of General Medicine and Geriatrics

Faculty of Medicine, University of Novi Sad, Novi Sad

³Department of Pathology and Forensic Medicine, Faculty of Medicine, University of Defence Belgrade, Belgrade

⁴Faculty of Medicine, University of Novi Sad, Novi Sad

⁵Department of Internal Medicine, Faculty of Medicine, University of Niš, Niš
Serbia

Abstract

Background: As hand osteoarthritis (HOA) is a highly prevalent disease, the purpose of the present study was to examine the relationship between structural damage of the hand in HOA patients and assess its impact on their hand function, pain, and satisfaction.

Methods: This prospective cross-sectional study included 60 postmenopausal women aged 60-70 years, all of whom underwent structural damage assessments using the Kellgren-Lawrence scale and the Altman Atlas, as well as completed the Michigan Hand Outcomes Questionnaire (MHQ) to assess their hand function, pain, and satisfaction. To examine the influence of HOA grade on these outcomes, patients were segregated into three groups (grade II-IV), and their average MHQ subscale scores were compared.

Results: The three groups differed in terms of scores achieved on all MHQ subscales: overall hand function-right hand (H =35.42, p <0.001), overall hand function-left hand (H =29.94, p <0.001), activities of daily living-right hand (H =39.88, p <0.001), activities of daily living-left hand (H =33.82, p <0.001), activities of daily living-both hands (H =30.93, p <0.001), activities of daily living-total (H =37.81, p <0.001), work performance (H =32.33, p <0.001), pain-right hand (H =27.94, p <0.001), pain-left hand (H =24.63, p <0.001), appearance-right hand (H =26.28, p <0.001), appearance-left hand (H =23.82, p <0.001), satisfaction-right hand (H =22.40, p =0.001), and satisfaction-left hand (H =26.71, p <0.001).

Conclusion: The study findings reveal that respondents with more severe structural damage experienced more significant pain, reported greater functional and work-related limitations, and were more dissatisfied with the function and appearance of their hands. HIPPOKRATIA 2022, 26 (1):7-12.

Keywords: Osteoarthritis, hand damage, hand radiography, outcome measure

Corresponding author: Jelena Zvekić-Svorcan, PhD, Department of Medical Rehabilitation, Faculty of Medicine, University of Novi Sad, 3 Hajduk Veljkova str., 21000 Novi Sad, Serbia, tel: +38121522172; fax: +381216615771, e-mail: zvekić.svorcan@gmail.com, jelena.zvekić-svorcan@mf.uns.ac.rs

Introduction

Osteoarthritis (OA) is the most common joint disease¹ and results in the deformity and functional disability of highly mobile or weight-bearing joints, thus causing considerable pain². While different approaches can be used to control the symptoms³, as there is presently no cure and hand⁴⁻⁶ is the most frequently affected part of the body, OA can significantly compromise a person's ability to work and actively participate in society⁷, posing a significant economic burden⁸. Although symptomatic hand osteoarthritis (HOA) prevalence in the general adult population varies depending on the country⁴, the es-

timates range from 3 to 8 %, equivalent to 300 million individuals worldwide⁹. HOA is more common in women, as the first symptoms typically appear with the onset of menopause^{10,11}.

HOA primarily affects distal and proximal interphalangeal joints and the base of the thumb and scaphotrapezotrapezoid joint¹, causing pain, stiffness, and loss of mobility while compromising grip strength^{4,12,13}. As the hands become deformed owing to the changes in their structure, many patients are dissatisfied with their appearance¹⁴. Although cartilage is most severely degraded due to OA, it also affects the whole joint, synovium, joint

ligaments, and subchondral bone¹⁵, causing systemic inflammation and active synovitis⁹. HOA usually manifests as joint space narrowing on radiographic images, accompanied by osteophytes, subchondral sclerosis, and subchondral cyst formation^{9,16}. While various tools can be used to assess the pain and HOA functional status, the Michigan Hand Outcomes Questionnaire (MHQ)¹⁴, comprising six scales, is the most widely used, as it was specifically designed for patients with hand disorders and, in addition to the hand function, it estimates subjective feelings and satisfaction¹⁷. As the present study aimed to evaluate the relationship between structural damage due to HOA and hand function, perceived pain, and satisfaction with the hand function and visual appearance in patients with hand osteoarthritis, MHQ was adopted for this purpose due to its comprehensive scope.

Material and Methods

This prospective cross-sectional study was approved by the Ethics Committee of the Special Hospital for Rheumatic Diseases of Novi Sad (decision No 14/30-18/016) and the Ethics Committee of the Faculty of Medicine in Novi Sad, Serbia (decision No 01-39/51/1). It was conducted at the Special Hospital for Rheumatic Diseases from April 2017 to April 2018 and involved 60 postmenopausal women aged between 60 and 70 years. All subjects assented to participate in this study and signed the informed consent forms. The sample size was determined based on the 7.5 % margin of error, 80 % confidence level, and 50 % incidence value. According to these criteria, the minimum number of participants was estimated at 59. The participants' OA progression in hand joints (based on radiographic images) was classified as II-IV grade according to the Kellgren-Lawrence (K-L) scale¹⁸, and pain in the hands was rated at ≥ 3 on the Visual Analogue Scale (VAS)¹⁹. Although VAS is a self-rating measure, it is a widely used and valid psychometric instrument designed to document and measure the characteristics of disease-related symptoms. VAS is a straight horizontal line of 100 mm length used to indicate subjective pain severity, with 0 mm denoting absence of pain and 100 mm the most severe pain. All participants

were also subjected to a thorough medical history review, physical examination, and laboratory tests in line with the widely adopted clinical standards. The Altman Atlas was used to establish the structural damage based on the presence and severity of radiographic features. These evaluations were complemented by physical examination, which included hand and hand joint inspection, palpation, and checking for the presence of nodules characteristic of HOA and signs of bone damage. All aforementioned processes were performed by the first author (rheumatologist) while a radiology specialist evaluated the X-ray images²⁰. At this stage, individuals who had an inflammatory rheumatic disease, tenosynovitis of the hand and carpal tunnel, or previous hand surgery, as well as individuals that used corticosteroid therapy or had physical therapy within the three months preceding the study, were informed that they were ineligible for participation. Those that met the study inclusion criteria were asked to complete the MHQ, allowing the sample to be segregated into three groups based on the HOA grade according to the K-L scale.

The MHQ consists of six subscales, which respectively measure overall hand function, work performance, activities of daily living (ADL), aesthetics, pain, and satisfaction. All items require a response on a five-point Likert-type scale, resulting in a total subscale score of 0-100, with higher scores signifying better hand function. The only exception is the pain subscale, where a greater score indicates more intense pain.

The three groups (corresponding to HOA II-IV grade) were homogeneous with respect to age ($p = 0.188$) and menopause duration ($p = 0.351$). The average age of the subjects in the HOA grade II, grade III, and grade IV groups was 65.50 ± 6 , 63.50 ± 10 , and 69.00 ± 6.38 , respectively, while their respective average menopause duration was 15.50 ± 9.25 , 15.50 ± 9.50 , and 18.50 ± 6.50 . As shown in Table 1, 57 participants (95 %) were right-handed, and the remaining three (5 %) were left-handed.

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 24.0. (IBM Corp., Armonk, NY, USA) and included descriptive statistics of the results as well as hypothesis testing. MHQ reliability

Table 1: Average age, menopause duration, and dominant hand of the 60 postmenopausal women aged 60-70 who were included in this prospective cross-sectional study.

	HOA grade II (n =20)	HOA grade III (n =20)	HOA grade IV (n =20)	P	All (n =60)
Age (years)	65.50 \pm 6.00	63.50 \pm 10.00	69.00 \pm 6.38	0.188 ^a	66.00 \pm 8.75
Me \pm IQR (Min–Max)	(60-70)	(60-70)	(60-70)		(60-70)
Menopause duration (years)	15.50 \pm 9.25	15.50 \pm 9.50	18.50 \pm 6.50	0.351 ^a	17.00 \pm 8.88
Me \pm IQR (Min–Max)	(7-22)	(10-28)	(7-30)		(7-30)
Dominant hand					
Right	19 (95 %)	18 (90 %)	20 (100 %)	0.349 ^b	57 (95.0 %)
Left	1 (5 %)	2 (10 %)	0 (0 %)		3 (5.0 %)

HOA: hand osteoarthritis, n: number, Me \pm IQR (Min–Max) = Median \pm Interquartile Range (Minimum–Maximum), ^a: Kruskal Wallis test, ^b: Likelihood Ratio test, p: statistical significance.

was assessed via Cronbach's α coefficient by measuring its internal consistency. As Cronbach's α values for all items exceeded the 0.70 threshold, and the correlation between items was ≥ 0.40 , all items met the reliability criterion and were connected to a sufficient degree. In addition, depending on the data type, significant parameters were described using medians, frequencies, and percentages. When reporting the findings, Interquartile Range (IQR) was adopted as the measure of deviation from the average and is reported in pertinent tables, along with the minimum and maximum values of the numerical variables. Utilizing the Kolmogorov-Smirnov and Shapiro-Wilk tests, data were found not normally distributed; thus, non-parametric statistics were used. Differences were tested by the Kruskal Wallis H test, and the Mann-Whitney U test was conducted for subsequent comparisons between groups, with the significance threshold set at $p < 0.05$.

Results

As shown in Table 2, the three groups differed in terms of scores achieved on all MHQ subscales: overall hand function-right hand ($H = 35.42$, $p < 0.001$), overall hand function-left hand ($H = 29.94$, $p < 0.001$), activities of daily living-right hand ($H = 39.88$, $p < 0.001$), activities of daily living-left hand ($H = 33.82$, $p < 0.001$), activities of daily living-both hands ($H = 30.93$, $p < 0.001$), activities of daily living-total ($H = 37.81$, $p < 0.001$), work performance ($H = 32.33$, $p < 0.001$), pain-right hand ($H = 27.94$, $p < 0.001$), pain-left hand ($H = 24.63$, $p < 0.001$), appearance-right hand ($H = 26.28$, $p < 0.001$), appearance-left hand ($H = 23.82$, $p < 0.001$), satisfaction-right hand ($H = 22.40$, $p = 0.001$), and satisfaction-left hand ($H = 26.71$, $p < 0.001$).

The Mann-Whitney U test revealed significant differences among the three groups on the following subscales: overall hand function-right hand, overall hand function-left hand, activities of daily living-right hand, activities of daily living-left hand, activities of daily living-both hands, daily activities-total, work performance, pain-left hand, appearance-right hand, and appearance-left hand. The HOA grade II group achieved the highest scores on these scales (indicating the best hand function), followed by the respondents in the HOA grade III group and the HOA grade IV group.

Pain in the right hand was equally intense in the HOA grade III and IV groups and was higher than in the HOA grade II group. There was no statistically significant difference in patients' satisfaction with the function of their hands between the grade II and grade III groups. In contrast, the grade IV group patients reported lower satisfaction (Table 3).

Discussion

OA is characterized by progressive articular cartilage degradation and the emergence of subchondral bone lesions²¹, which are accompanied by morphological and radiological changes²². In this study, we assessed the re-

lationship between structural damage of the hand in postmenopausal women with HOA (estimated via the K-L grade and the Altman Atlas findings) and hand function, perceived pain, and patient's satisfaction with the hand function and visual appearance, as measured via MHQ. The analyses revealed that patients with more severe OA damage (established via radiological assessments) experienced more significant pain and suffered from more extensive functional and work-related limitations. They were also more dissatisfied with the function and appearance of their hands.

The highest hand function, ADL, and work performance MHQ scores were obtained by patients with HOA grade II, followed by those in the grade III group, and finally, the grade IV group. These findings are noteworthy, given that extant studies focusing on the association between the severity of radiological damage to the hand, functionality, activities of daily living, and work performance have yielded inconsistent results^{14,23,24,25}.

On the other hand, our results concur with those obtained by other authors indicating that pain intensity is correlated with the K-L grade^{25,26}. In our patient cohort, a correlation between pain intensity and K-L grade was present in both hands, except for K-L grade III and IV, and pain intensity in the right hand, which was comparable but was statistically significantly more intense compared to K-L grade II. Likewise, Kroon et al²⁷ found an association between structural damage in the thumb base affected by osteoarthritis and pain. Conversely, Haugen et al²³ reported a progressively greater frequency of joint tenderness with the increase in OA grade and found only a weak association between the severity of OA damage and pain, which may be due to the use of different outcome measures. Indeed, Kroon et al¹⁴ compared individual MHQ items with the Australian/Canadian Hand Osteoarthritis Index (AUSCAN), concluding that the two instruments evaluate different aspects of pain. Our cohort's satisfaction with left and right hand functionality also depended on the HOA severity. It was statistically significantly lower in the group with HOA grade IV compared to that reported by patients in the HOA grade II and III groups, concurring with the findings reported by Liu et al based on a Dutch study in which radiographic hand damage was associated with dissatisfaction²⁸. Likewise, in addition to pain and physical function, over a quarter of patients with HOA that took part in the study conducted by Leung et al²⁹ asserted that emotional health and aesthetic concerns significantly impacted their quality of life. Similar to Kroon et al¹⁴, who reported a statistically significant difference between the MHQ aesthetic subscale scores achieved by patients with more and less severe HOA damage, we found a negative correlation between the grade of radiographic damage and the MHQ aesthetic subscale score.

In conclusion, our findings strongly support the association between the degree of structural damage and clinical burden in patients with HOA. Moreover, patients with more severe structural hand damage are more likely

Table 2: The Michigan Hand Outcomes Questionnaire score concerning the grade of hand damage regarding the 60 post-menopausal women who participated in the study.

		Min	Max	Me	IQR	H	p
Overall hand function, right hand	HOA grade II	25.00	65.00	50.00	22.50	35.42	<0.001
	HOA grade III	15.00	50.00	35.00	13.75		
	HOA grade IV	5.00	40.00	17.50	15.00		
	Total	5.00	65.00	35.00	20.00		
Overall hand function, left hand	HOA grade II	25.00	70.00	50.00	17.50	29.94	<0.001
	HOA grade III	20.00	55.00	37.50	18.75		
	HOA grade IV	5.00	50.00	20.00	15.00		
	Total	5.00	70.00	37.50	25.00		
Activities of daily living, right hand	HOA grade II	30.00	90.00	60.00	27.50	39.88	<0.001
	HOA grade III	20.00	45.00	35.00	13.75		
	HOA grade IV	10.00	45.00	15.00	13.75		
	Total	10.00	90.00	35.00	23.75		
Activities of daily living, left hand	HOA grade II	30.00	90.00	60.00	25.00	33.82	<0.001
	HOA grade III	20.00	50.00	42.50	13.75		
	HOA grade IV	10.00	55.00	22.50	17.50		
	Total	10.00	90.00	42.50	28.75		
Activities of daily living, both hands	HOA grade II	28.57	82.14	53.57	18.75	30.93	<0.001
	HOA grade III	21.43	57.14	41.07	16.07		
	HOA grade IV	10.71	42.86	35.71	14.29		
	Total	10.71	82.14	41.07	17.86		
Activities of daily living, total ADL	HOA grade II	30.00	90.00	60.00	26.25	37.81	<0.001
	HOA grade III	22.50	47.50	36.25	11.25		
	HOA grade IV	12.50	50.00	20.00	14.38		
	Total	12.50	90.00	36.25	24.38		
Work performance	HOA grade II	35.00	100.00	70.00	22.50	32.33	<0.001
	HOA grade III	25.00	70.00	42.50	23.75		
	HOA grade IV	5.00	45.00	35.00	15.00		
	Total	5.00	100.00	40.00	38.75		
Pain, right hand	HOA grade II	30.00	85.00	65.00	18.75	27.94	<0.001
	HOA grade III	65.00	95.00	82.50	5.00		
	HOA grade IV	70.00	100.00	82.50	10.00		
	Total	30.00	100.00	80.00	15.00		
Pain, left hand	HOA grade II	15.00	55.00	45.00	23.75	24.63	<0.001
	HOA grade III	5.00	80.00	60.00	28.75		
	HOA grade IV	40.00	80.00	70.00	8.75		
	Total	5.00	80.00	57.50	25.00		
Aesthetics, right hand	HOA grade II	25.00	93.75	50.00	17.19	26.28	<0.001
	HOA grade III	12.50	100.00	28.13	18.75		
	HOA grade IV	6.25	50.00	25.00	10.94		
	Total	6.25	100.00	31.25	25.00		
Aesthetics, left hand	HOA grade II	25.00	93.75	50.00	18.75	23.82	<0.001
	HOA grade III	12.50	100.00	28.13	31.25		
	HOA grade IV	6.25	56.25	25.00	6.25		
	Total	6.25	100.00	34.38	29.69		
Satisfaction, right hand	HOA grade II	16.67	83.33	35.42	12.50	22.40	0.001
	HOA grade III	8.33	95.83	31.25	20.83		
	HOA grade IV	4.17	41.67	12.50	12.50		
	Total	4.17	95.83	29.17	20.83		
Satisfaction, left hand	HOA grade II	16.67	75.00	45.83	8.33	26.71	<0.001
	HOA grade III	16.67	95.83	27.08	25.00		
	HOA grade IV	8.33	37.50	12.50	11.46		
	Total	8.33	95.83	29.17	29.17		

Min: minimum value for the sample, Max: maximum value for the sample, Me: median, IQR: Interquartile Range, H: Kruskal Wallis Test, p: statistical significance, HOA: hand osteoarthritis.

Table 3: The Michigan Hand Outcomes Questionnaire score concerning the grade of hand damage, comparison across hand osteoarthritis grade II-IV groups.

	A vs. B	A vs. C	B vs. C
Overall hand function, right hand	0.000	0.000	0.000
Overall hand function, left hand	0.000	0.000	0.001
Activities of daily living, right hand	0.000	0.000	0.000
Activities of daily living, left hand	0.000	0.000	0.000
Activities of daily living, both hands	0.000	0.000	0.001
Activities of daily living, total ADL	0.000	0.000	0.000
Work performance	0.000	0.000	0.015
Pain, right hand	0.000	0.000	0.301
Pain, left hand	0.000	0.000	0.025
Aesthetics, right hand	0.001	0.000	0.050
Aesthetics, left hand	0.004	0.000	0.050
Satisfaction, right hand	0.121	0.000	0.001
Satisfaction, left hand	0.076	0.000	0.000

Data were analyzed by Mann-Whitney U Test, HOA: hand osteoarthritis, Group A: HOA grade II, Group B: HOA grade III, Group C: HOA grade IV.

to have more intense pain, experience more significant work limitations, and report poorer satisfaction with hand function and appearance.

Conflict of interest

The authors declare no financial interests and/or conflict of interest related to this study.

Acknowledgement

This original scientific paper is part of a doctoral dissertation titled “The link between hand functionality in osteoarthritis and bone density in postmenopausal women as measured by central dual-energy X-ray absorptiometry”.

References

- Williams M, Temperley D, Murali R. Radiology of the hand. *Orthop Trauma*. 2019; 33: 45-52.
- Vargas CA, Sandoval KA, Salvo CA, Del Sol M, Ottone NE. Exercise in rats osteoarthritis. Morphological aspects and literature review. *Int J Morphol*. 2020; 38: 481-491.
- Gigis I, Fotiadis E, Nenopoulos A, Tsitas K, Hatzokos I. Comparison of two different molecular weight intra-articular injections of hyaluronic acid for the treatment of knee osteoarthritis. *Hippokratia*. 2016; 20: 26-31.
- Qin J, Barbour KE, Murphy LB, Nelson AE, Schwartz TA, Helmick CG, et al. Lifetime Risk of Symptomatic Hand Osteoarthritis: The Johnston County Osteoarthritis Project. *Arthritis Rheumatol*. 2017; 69: 1204-1212.
- Zvekić-Svorcan J, Stamenković B, Minaković I, Krasnik R, Janković T, Mikov A. Risk factors for hand osteoarthritis. *Med Pregl*. 2020; 73: 81-87.
- Shah K, Yang X, Lane JCE, Collins GS, Arden NK, Furniss D, et al. Risk factors for the progression of finger interphalangeal joint osteoarthritis: a systematic review. *Rheumatol Int*. 2020; 40: 1781-1792.
- Loef M, Damman W, de Mutsert R, Rosendaal FR, Kloppenburg M. Health-related Quality of Life in Patients with Hand Osteoarthritis from the General Population and the Outpatient Clinic. *J Rheumatol*. 2020; 47: 1409-1415.
- Stoffer-Marx MA, Klinger M, Luschin S, Meriaux-Kratochvila S, Zettel-Tomenendal M, Nell-Duxneuner V, et al. Functional consultation and exercises improve grip strength in osteoarthritis of the hand - a randomised controlled trial. *Arthritis Res Ther*. 2018; 20: 253.
- Abramoff B, Caldera FE. Osteoarthritis: Pathology, Diagnosis, and Treatment Options. *Med Clin North Am*. 2020; 104: 293-311.
- Watt FE. Hand osteoarthritis, menopause and menopausal hormone therapy. *Maturitas*. 2016; 83: 13-18.
- Burkard T, Rauch M, Spoendlin J, Prieto-Alhambra D, Jick SS, Meier CR. Risk of hand osteoarthritis in new users of hormone replacement therapy: A nested case-control analysis. *Maturitas*. 2020; 132: 17-23.
- Sun X, Zhen X, Hu X, Li Y, Gu S, Gu Y, et al. Osteoarthritis in the Middle-Aged and Elderly in China: Prevalence and Influencing Factors. *Int J Environ Res Public Health*. 2019; 16: 4701.
- Güven N, Dinçer F, Çetin A, Güven SC. Hand strength and dexterity in interphalangeal hand osteoarthritis and effects of osteophyte formations. *Adv Rheumatol*. 2020; 60: 41.
- Kroon FPB, Boersma A, Boonen A, van Beest S, Damman W, van der Heijde D, et al. Performance of the Michigan Hand Outcomes Questionnaire in hand osteoarthritis. *Osteoarthritis Cartilage*. 2018; 26: 1627-1635.
- Hussain SM, Cicuttini FM, Alyousef B, Wang Y. Female hormonal factors and osteoarthritis of the knee, hip and hand: a narrative review. *Climacteric*. 2018; 21: 132-139.
- Marshall M, Watt FE, Vincent TL, Dziedzic K. Hand osteoarthritis: clinical phenotypes, molecular mechanisms and disease management. *Nat Rev Rheumatol*. 2018; 14: 641-656.
- Hulkkonen S, Repo JP, Häkkinen A, Karppinen J, Ryhänen J. Cross-Cultural Adaptation and Validation of the Finnish Version of the Michigan Hand Outcomes Questionnaire. *Scand J Surg*. 2020; 109: 159-165.
- Kohn MD, Sassoon AA, Fernando ND. Classifications in Brief: Kellgren-Lawrence Classification of Osteoarthritis. *Clin Orthop Relat Res*. 2016; 474: 1886-1893.
- Delgado DA, Lambert BS, Boutris N, McCulloch PC, Robbins AB, Moreno MR, et al. Validation of Digital Visual Analog Scale Pain Scoring With a Traditional Paper-based Visual Analog Scale in Adults. *J Am Acad Orthop Surg Glob Res*. 2018; 2: e088.
- Altman RD, Gold GE. Atlas of individual radiographic features in osteoarthritis, revised. *Osteoarthritis Cartilage*. 2007; 15 Suppl A: A1-A56.
- Vargas CA, Vásquez B, Veuthey C, del Sol M, Sandoval C, Ottone NE. Histologic description of monosodium iodoacetate damage in rat humeral joint. *Int J Morphol*. 2019; 37: 1551-1556.
- Macías-Hernández SI, Zepeda-Borbón ER, Lara-Vázquez BI, Cuevas-Quintero NM, Morones-Alba JD, Cruz-Medina E, et al. Prevalence of clinical and radiological osteoarthritis in knee, hip, and hand in an urban adult population of Mexico City. *Reu-*

- matol Clin (Engl Ed). 2020; 16: 156-160.
23. Haugen IK, Slatkowsky-Christensen B, Bøyesen P, van der Heijde D, Kvien TK. Cross-sectional and longitudinal associations between radiographic features and measures of pain and physical function in hand osteoarthritis. *Osteoarthritis Cartilage*. 2013; 21: 1191-1198.
 24. Ceceli E, Gül S, Borman P, Uysal SR, Okumuş M. Hand function in female patients with hand osteoarthritis: relation with radiological progression. *Hand (N Y)*. 2012; 7: 335-340.
 25. Kodama R, Muraki S, Oka H, Iidaka T, Teraguchi M, Kagotani R, et al. Prevalence of hand osteoarthritis and its relationship to hand pain and grip strength in Japan: The third survey of the ROAD study. *Mod Rheumatol*. 2016; 26: 767-773.
 26. Schaefer LF, McAlindon TE, Eaton CB, Roberts MB, Haugen IK, Smith SE, et al. The associations between radiographic hand osteoarthritis definitions and hand pain: data from the osteoarthritis initiative. *Rheumatol Int*. 2018; 38: 403-413.
 27. Kroon FPB, van Beest S, Ermurat S, Kortekaas MC, Bloem JL, Reijniere M, et al. In thumb base osteoarthritis structural damage is more strongly associated with pain than synovitis. *Osteoarthritis Cartilage*. 2018; 26: 1196-1202.
 28. Liu R, Damman W, Beart-van de Voorde L, Kaptein AA, Rosendaal FR, Huizinga T, et al. Aesthetic dissatisfaction in patients with hand osteoarthritis and its impact on daily life. *Scand J Rheumatol*. 2016; 45: 219-223.
 29. Leung YY, Li JC, Thumboo J. Domains rated as important by patients with hand osteoarthritis. *Int J Rheum Dis*. 2019; 22: 2045-2051.