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Treatment of patients with hand osteoarthritis : outcome measures, patient satisfaction, and economic evaluation

Marks, M.

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Author: Marks, Miriam
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CHAPTER **EIGHT**

SUMMARY AND GENERAL DISCUSSION



SUMMARY

Osteoarthritis (OA) is the most prevalent joint disorder leading to serious functional limitations and reduced quality of life, as well as to considerable social and economic costs[1-3]. In the hand, the distal interphalangeal (DIP) joints are most often affected by OA, followed by the trapeziometacarpal (TMC) and the proximal interphalangeal (PIP) joints[4-6].

Patients affected by hand OA usually report significant restrictions in their daily lives[3, 7, 8]. Pain combined with reduced finger joint mobility and decreased grip strength forces them to reduce their daily hand-related activities or even to avoid specific tasks. The tasks most commonly described as difficult are wringing out washcloths, and opening jars and bottles[9]. Treatment options for patients with hand OA include pharmacological, non-pharmacological, and surgical procedures[1, 10, 11].

The aim of this thesis, which is divided into two parts, was to investigate the limitations in daily life, outcome measures, clinical outcomes with the emphasis on patient satisfaction, and economic aspects of the treatment of hand OA, focussing on patients suffering from TMC OA.

Part ONE, comprising **chapters two, three,** and **four,** describes patients' limitations in daily life and relevant outcome measures. **Part TWO** contains **chapters five, six,** and **seven** and investigates the outcomes of surgical and non-surgical management of hand OA, with respect to patient satisfaction and economic aspects.

Part ONE

Chapter two addressed patients' limitations in daily life and investigated the particular problem of opening food containers. The aim was to develop guidelines for the industry on how to produce easy-to-open packaging. In a cross-sectional study, we investigated the forces that patients can apply to tear tabs and compared the results with normative data from a healthy age- and gender-matched population. We included 100 patients with different hand disorders. The pinch pull force (PPF) applied to tear tabs of different lengths and materials (aluminium, plastic) was measured with a specially designed device. Key pinch was measured with a pinch gauge. Normative data were taken from another study on 402 healthy adults. The results showed that patients were able to apply most force to the longest aluminium tab, using the key grip, but this was still only 53% of the force exerted by healthy people. Furthermore, we found that key pinch strength determines PPF ($R^2 = 0.548$, $p \leq 0.001$). When asked about difficulties with different types of packaging, 82% of the patients mentioned jam jars, 78% peelable meat/cheese packaging, and 69% bottles. We therefore recommend the industry to provide long aluminium tear tabs on their packaging. Furthermore, healthcare professionals are encouraged to measure key pinch to detect difficulty in opening packages.

The objective of **chapter three** was to reveal all the outcome measures used in studies on TMC OA and evaluate their measurement properties. In a two-step systematic literature review, we first identified studies including TMC OA patients and extracted all the outcome measures. They were categorised according to the Outcome Measures in Rheumatology (OMERACT) core set for OA, including five dimensions: pain, physical function, global assessment, imaging, and quality of life. First, 316 articles were identified, including 101 different outcome measures, mostly addressing the OMERACT pain and function domains but under-representing quality of life. Secondly, we

retrieved articles on the measurement properties of the outcome measures identified for TMC OA patients and found 12 articles investigating measurement properties of 12 outcome measures. The Disabilities of the Arm, Shoulder and Hand questionnaire (DASH) and the Patient-Rated Wrist Evaluation (PRWE) were the tools most extensively studied. None of the studies examined all measurement properties. Positive ratings were seen for the DASH, the quickDASH, the Australian / Canadian Osteoarthritis Hand Index (AUSCAN), and the Nelson Score. In contrast, the Eaton classification, the carpometacarpal grind test, and the Hand Functional Index of the Keitel Functional Test rated poorly. Ratings for the PRWE and the Short Form 36 (SF-36) were equivocal. The methodological quality of these studies was fair to poor, implying that no recommendations for the use of any of the outcome measures can be made from the literature.

Given the lack of evidence on outcome measures for TMC OA, the reliability, validity, and responsiveness of the Michigan Hand Outcomes Questionnaire (MHQ) was investigated as described in **chapter four**. The prospective cohort study included 177 patients diagnosed with TMC OA, who received either conservative or surgical treatment. At baseline and at one year following the beginning of the treatment, we measured key pinch strength and the patients filled out the MHQ, the DASH, and the Short Form 12 (SF-12). They also completed these questionnaires 2 - 11 days after the last study visit. In order to analyse the measurement properties of the MHQ, we calculated test-retest reliability (intraclass correlation coefficient, ICC), internal consistency (Cronbach's alpha for the six subscales), construct validity (Pearson's correlation coefficient, r), responsiveness (effect sizes), and the minimal important change (MIC). The results showed that the mean MHQ total score for surgical patients increased from 48 ± 14 at baseline to 75 ± 18 at one year ($p \leq 0.001$). In contrast, no treatment effect was observed in the conservatively treated group ($p = 0.74$). The MHQ total score showed excellent test-retest reliability (ICC = 0.95) and correlated strongly with the DASH ($r = -0.77$). Internal consistency of the MHQ subscales ranged between 0.77 and 0.89. A large effect size of 1.7 was found for the surgical patients, with an MIC of 17 points. Based on these results, we concluded that the MHQ demonstrates good reliability, validity, and responsiveness in patients with TMC OA and it can be recommended as a suitable assessment tool in this population.

Part TWO

Chapter five aimed to identify which factors are associated with patient satisfaction after orthopaedic interventions in the hand. Assessing patient satisfaction is becoming more and more important, because it contributes to the continuous evaluation of healthcare, for which the patient and society are paying. Furthermore, satisfied patients show greater compliance and continue to attend for treatment[12, 13]. Quantification is demanding because a variety of factors, as yet poorly defined, influence the patient's perception of a satisfactory outcome. We conducted a literature review including studies on determinants of treatment satisfaction and nonspecific overall satisfaction of patients with hand problems. The results indicated that patient satisfaction is multifactorial. There is moderate evidence that pain/symptoms, activities of daily living/function, aesthetics, and embodiment influence patient satisfaction. Furthermore, data indicated that strength, range of motion, fulfilment of expectations, deformity, workers' compensation, and length of follow-up correlated with satisfaction.

Knowledge of these determinants may lead to a more detailed decision-making process, thus contributing to improved treatment outcomes and cost-effectiveness.

In routine practice, the recommended treatment goals are relief of pain or symptoms and restoration of the important individual functions, while taking the appearance of the hand and body-self unity into account. Restoration of strength, range of motion, and any deformity should also be addressed. In addition to evaluating these objective outcomes, the impact of the patients' individual expectations, whether they are involved in worker's compensation, and the time between treatment and follow-up all have to be considered.

The objective of **chapter six** was to analyse the outcomes of surgical and conservative treatment in patients with TMC OA and to evaluate determinants of treatment satisfaction. We conducted a prospective cohort study on patients with TMC OA who received either surgical or conservative treatment. Patients filled out the MHQ at baseline and 3, 6, and 12 months after the intervention. On 5-point Likert scales, they reported baseline expectations and their fulfilment at each follow-up visit, as well as satisfaction with treatment. These variables at baseline and 1 year, as well as sociodemographic and disease-related variables were entered into one ordered logistic regression model for surgical patients and into another for conservatively treated patients, in order to identify determinants of patient satisfaction at 1 year. This study included 165 patients, 97 of whom received surgery. Surgical patients improved continuously from a MHQ score of 47 ± 15 at baseline to 80 ± 16 at 1 year ($p \leq 0.001$). In the conservatively treated group, an improvement was found between baseline (61 ± 13) and 6 months (68 ± 15; $p \leq 0.001$), but not at 1 year (66 ± 17; $p = 0.055$). Expectations being fulfilled at 1 year was an important determinant of satisfaction in both groups. Based on these results, we concluded that surgery leads to a significant improved outcome up to 1 year. Conservative treatment is significantly effective for 6 months. As the fulfilment of expectations was an important determinant of satisfaction in both groups, we emphasised the importance of providing patients with comprehensive information prior to the intervention, in order to ensure that their expectations of the treatment outcome are realistic.

Chapter seven presented the economic aspects of conservative and surgical treatment of patients with TMC OA, analysing the costs associated with healthcare and with loss of productivity. This prospective cohort study included patients with TMC OA who received either conservative (corticosteroid injection) or surgical treatment (trapeziectomy with ligament reconstruction and tendon interposition or arthrodesis). Healthcare costs were measured using the earnings of our clinic in Swiss francs (CHF). Patients were assessed at baseline and 3, 6, and 12 months after the intervention. Employed patients filled out the Work Productivity and Activity Impairment Questionnaire (WPAI) to assess absenteeism, presenteeism, and overall costs due to loss of productivity. We included 161 patients, of whom 58 were in employment. Healthcare costs were CHF 10,303 in the surgery group and CHF 622 in the conservatively treated group ($p \leq 0.001$). The total productivity loss in the surgical group increased from baseline to 3 months (50% versus 64%; $p = 0.136$) and decreased significantly from 3 to 6 months (64% versus 33%; $p \leq 0.001$). Total productivity loss in the conservatively treated group was more stable over time (52% at baseline to 48% at 1 year, $p = 0.051$). The annual healthcare and productivity costs of CHF 20,210 estimated for the surgical group were higher than the CHF 6,877 estimated for the conservatively treated group ($p \leq 0.001$). In conclusion, surgery was

associated with considerably higher costs than conservative treatment, with respect to both healthcare and loss of productivity. The extent of improved productivity after more than a year and its related economic consequences should be the subjects of further research.

DISCUSSION

The research for this thesis has shown that patients with hand OA report severe limitations in daily life, in particular when opening food packaging. We developed guidelines for the industry on the production of easy-to-open food packaging. A variety of patient-reported outcomes are currently used to measure interventions in patients with TMC OA, but none of them has overall positive ratings. We were able to show that the MHQ demonstrates good reliability, validity, and responsiveness in patients with TMC OA and we recommend it as a suitable assessment tool in this population. Regarding satisfaction we found that many variables determine patient satisfaction with treatment – relief of pain or symptoms and restoration of hand function being the most important determinants in patients with orthopaedic hand conditions. In patients with TMC OA, the fulfilment of expectations was found to be an important determinant of satisfaction. In the analysis of two different treatment strategies, conservative and surgical management, in patients with TMC OA, we showed that surgery leads to significantly improved hand function after one year, while conservative treatment seems to be most effective in the first 6 months. From an economic point of view, however, surgery was associated with considerably higher costs than conservative treatment, with respect to both healthcare and loss of productivity.

Patients' limitations in daily life

So far, several studies have described activity limitations in patients with hand OA. Most of the activities addressed are pinch-related, such as writing, moving small objects, turning keys in locks, as well as grasping and carrying large objects, for example unscrewing jars[14-16]. In recent years, activities of daily living have changed. Although writing by hand was an important activity 20 years ago, people nowadays use computers, laptops, tablets, and smartphones. Besides the many advantages of using computers and mobile devices for work, it also leads to new complaints. Researchers have shown that the time spent using a mobile phone is significantly associated with pain in the base of the thumb, and that excessive texting is related to TMC OA[17, 18]. Another very relevant but under-investigated issue in daily life is the opening of food packaging, which was addressed in **chapter two**. Up to 90% of the over 60s have difficulty opening peelable packaging, such as cheese/meat packaging, or are even unable to do so[19]. In particular, patients with hand disorders experience difficulties in opening food containers due to pain, loss of grip strength, and reduced dexterity[20-22]. As demographic aging in Europe will increase in the coming years, the number of people with hand conditions and thus difficulties in opening packaging will rise correspondingly. The ease of opening food containers will therefore be increasingly important, not only to consumers but also to producers wanting to satisfy their clients' needs and achieve high brand loyalty[23].

More than 30 years ago, in the early 80s, Berns identified the issue of opening food containers for healthy as well as for handicapped people[24]. He also measured the forces that patients were able to apply to different types of food packaging and provided norm data useful for the industry[24]. However, opening packaging requires more than just hand strength. Besides

manual function, sensitivity is important when opening consumer products, as are visual and cognitive aspects[19]. Easy-to-open packaging not only has to be opened without much force but also depends on such factors as the visibility and simplicity of the opening mechanism[20, 25]. Even small changes in the size of the tear tab, the material used, its geometry or the design therefore have a large impact on the ease of opening the packaging[23, 25-27].

Although researchers[23, 25-32] other than Berns[24] have also documented the issue of opening food containers, the industry in Germany and Switzerland has not yet put much effort into the development of easy-to-open packaging.

Based on our results presented in **chapter two**, a Swiss retailer (Coop, Basel) initiated a project to develop easy-to-open food packaging. They aimed to optimise peelable meat packaging. The issue with the old packaging was that it needed a great deal of force to open it because the packs were sealed so strongly. Furthermore, the space provided for holding the tear tab was too small and the plastic cover often tore during opening. The technical optimisation process addressed these issues by ensuring that sealing parameters, including time, temperature, and pressure, were adapted in such a way as to make the packaging easier to open while the contents remained safely wrapped. The sealing seam and its tear contour were changed in order to provide optimal force distribution during opening. Another innovation was an additional notch, the size of a thumb or fingertip, placed laterally in the bottom plastic foil. A notch was put on each side, so that it could be used easily by left-handed as well as right-handed persons. In order to evaluate whether these technical optimisations were successful, we performed a cross-sectional study on 100 patients with hand osteoarthritis[33]. The results provide good evidence that patients with hand OA are significantly more satisfied with the optimised meat packaging than with the old-style packs. When patients with hand disorders are satisfied with the optimised packaging, we can assume that healthy people will also be happy with it. We have shown that it is possible for manufacturers today to produce easy-to-open food packages that afford greater consumer satisfaction[33].

Difficulty in opening packaging is also seen when taking medicines[34]. Efforts were made to produce an easy-to-open screw-cap container, although it had to be withdrawn from the market due to cost-effectiveness issues[34]. In cases where patients report difficulties opening their medicine containers, pharmacists could give the patient some tips and tricks, suggest helpful tools, or even remove tablets from the packs and store them in a user-friendly container[34].

Further research should analyse the difficulties patients with hand disorders experience in opening other kinds of packaging, so that recommendations for optimisation procedures can be made to the industry. However, not all types of packaging can be made easier to open, because the safety of the contents is the retailer's first priority. In such cases, it would be useful to develop special assistive devices which could be sold together with the product.

Outcome measures

Standardised outcome measures are essential to monitor a disease process and to evaluate the outcome of treatment[35]. Nowadays not only patients and health professionals are interested in outcomes but also hospital managers, lawyers, policy-makers, and the media[36]. Which outcome measures should be used for a comprehensive assessment of the health status and treatment outcome in patients with TMC OA has not yet been defined[36].

This topic was investigated in **chapter three**, with a systematic review of the outcome measures used in TMC OA studies**.** We found a wide variety of outcome measures, with pain and function being used most frequently and QoL clearly under-represented. Studies rarely examined the measurement properties of outcome measures specifically for patients with TMC OA, and the methodological quality of those that did so was only fair, so that it is not yet possible to make any recommendations for the use of a particular outcome measure.

Statistical comparison of different interventions remains unfeasible because of the variety of different outcome measures used in the past. This aspect has also been emphasised in systematic reviews on the treatment of TMC OA[37] and hand OA[7]. The finding that numerous tools (some self-developed) have been used to assess the effectiveness of treatment highlights the need to develop standardised and validated outcome measures for patients with TMC OA, in order to facilitate comparisons of patient populations and the outcomes of different surgical and non-surgical procedures.

The observed predominance of objective measures (such as muscle strength and range of motion) shows that many researchers still do not make the subjective patient perspective their primary focus. This implies under-representation of concepts such as the psychological state, appearance of the hand, and leisure activities, which are important to patients with hand OA[38].

Another issue with the current patient-reported outcome measures, most of them developed in the late 1990s or in the early 2000s, is that they sometimes include old-fashioned items. The DASH, for example, includes an item about difficulties with writing. Nowadays, people hardly ever write by hand. They use computers, laptops, tablets, and smartphones instead. However, none of the various patient-reported outcome measures considers these aspects, not even the thumb-specific Nelson score developed in 2007[39]. Questionnaires developed in the late 1990s need to be updated, replacing old-fashioned items with current ones. Patients should be involved in the revision process, to ensure that items relevant to the target population are covered.

Apart from its measurement properties, other characteristics of a questionnaire such as availability and practicability have to be considered[40, 41]. Several questionnaires carry licence fees. Some questionnaires are easy to score, while others need special software. The number of items and the time required to fill out the questionnaire also have to be considered, bearing in mind the burden on the patient. Furthermore, the researcher has to be aware of the aim and content of the outcome measure, in order to determine the right outcome measure for the intended purpose[40, 41].

Other useful tools to describe the patient's condition comprehensively are the International Classification of Functioning, Disability and Health (ICF) core sets. The ICF offers a comprehensive understanding of the individual health condition based on body functions and structures, activities, participation, personal attributes and environmental factors, providing a scientific basis for studying health, health-related states, outcomes, and the related determinants[42]. Three core sets might be relevant to patients with TMC OA: the ICF core set for OA[43], although it focusses more on hip and knee OA; the ICF core set for hand conditions[44]; and the brief ICF core set for hand conditions[45]. The core set for hand conditions covers 117 categories of functioning, potentially relevant to individuals with any hand condition, while the brief core set covers 23 categories[45]. These core sets assist clinicians in planning treatment from a comprehensive perspective, taking into account not only the body functions and structures

but also psychological aspects, difficulties in daily living and participation, and the individual's environment. There is also a rating scale available, the ICF qualifier, which is useful for evaluating the outcome of an intervention[45].

An important point when conducting a systematic literature review, as we did in **chapter three**, is the assessment of the methodological quality of the studies included. However, there are no uniform guidelines for assessing different types of studies. The Cochrane collaboration recommends its risk of bias tool for randomised controlled trials (RCTs)[46]. There are various checklists and scores available for observational studies, but none of them can be recommended as a gold-standard[47]. The Structured Effectiveness Quality Evaluation Scale (SEQES)[48] seems to be useful in determining the quality of both RCTs and observational studies. This checklist consists of 24 items, including the domains of study question and design, subjects, intervention, outcomes, analysis, and recommendations. Each item is scored on a three-point scale (0-2), giving a maximum of 48, with higher scores indicating higher methodological quality. However, one issue with the SEQES tool is that scores for observational studies are considerably lower than those of RCTs, because some items are designed specifically for RCTs[48]. Furthermore, it has not yet been tested for reliability and validity. Other common checklists, such as the Consolidated Standards of Reporting Trials (CONSORT)[49], the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA)[50, 51], and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)[52] statements, are not intended to serve as quality appraisal tools but to guide authors when reporting RCTs, systematic reviews, and observational studies, respectively. Guidelines for the evaluation of the methodological quality of studies on the measurement properties of health-related patient-reported outcomes are described in the COnsensus-based Standards for the selection of health status Measurement INstruments (COSMIN) checklist[53-55]. This checklist is useful when selecting a measurement tool, peer-reviewing a manuscript, designing or reporting a study on measurement properties, and for educational purposes[55].

The results of **chapter three** indicated that more research is needed on hand-specific questionnaires, to determine which are the most suitable for detecting changes in patients with TMC OA. The next step required is to investigate the measurement properties of hand-specific questionnaires that have not yet been evaluated in patients with TMC OA. The review also emphasised that these studies need to be methodologically sound before we can make any firm recommendations about the use of specific tools.

Our next step towards identifying suitable outcome measures for patients with TMC OA was an evaluation of the MHQ, and this was described in **chapter four.** The results of the study provide evidence that the MHQ is a reliable, valid, and responsive tool for assessing treatment outcomes in patients with TMC OA. Compared with the DASH, the hand-specific MHQ showed more favourable results for internal consistency, responsiveness, and missing items, indicating that it is more suitable for patients with conditions affecting the thumb.

In our study, internal consistency for the MHQ was satisfactory, although item redundancy was apparent in other studies[56]. For that reason, and because patients need a relatively long time to complete the questionnaire[57, 58], a short form of the MHQ has recently been developed[59]. The BriefMHQ shows similar measurement properties to the original version and is highly recommended as a more efficient tool in large studies, as a cross-sectional screening

tool, and for documenting the outcome in routine clinical practice, as it reduces responder burden and increases response rates[59, 60]. Use of the original MHQ is still advocated, however, as it provides a more comprehensive analysis of the patient's condition[59]. In addition, the full MHQ can assess the two hands separately, so that stratification for hand dominance or affected hand is possible[56], something which neither the BriefMHQ nor the DASH allows.

Regarding responsiveness, the lowest effect size related to the MHQ aesthetics subscale. This fact, combined with the relatively high baseline scores and the ceiling effect of this subscale, indicates that the appearance of the hand is not as important to patients with TMC OA as it is to patients with rheumatoid arthritis[56], for example. On average, patients who underwent metacarpophalangeal joint arthroplasty had baseline values in the MHQ aesthetics subscale 40 points lower than our patients, and the standardised response mean (SRM) was very high at 1.2[56].

When interpreting change scores of an outcome measure, it has to be considered whether they are based at a group level or at an individual level[61]. On a group level, smaller changes may be interpreted as important, whereas larger changes are required at an individual level before they are confidently accepted as indicating a meaningful change[61].

The MIC[62], which was introduced by Guyatt et al.[63], facilitates the interpretation of change scores at an individual level. The MIC is the smallest change in score in the construct to be measured that patients perceive as important[54]. Two approaches to calculating the MIC are described in the literature: the anchor-based and the distribution-based method[64, 65].

The anchor-based approach that we used in **chapter four** requires an external criterion, the anchor. This might be a global question about the perceived change in the condition over a certain time, used to identify patients who have changed to a small but meaningful degree and others who have not changed. The MIC can now be calculated using a receiver operating characteristic (ROC) curve, where the optimal cut-off point reflects the MIC. Another method is the mean-change method, where the MIC is defined as the change value of the patients who consider themselves to be slightly improved[62, 64, 65].

The advantage of the anchor-based approach is that patient-related information about the perceived change is explicitly incorporated. However, it fails to take into account the variability of the assessment tool scores in the sample[65].

Distribution-based approaches take the distribution of the tool scores and its variability into account. They express the observed change in a group of patients in a standardised way. Frequently used parameters are standard deviation (SD), effect size (ES), and the standard error of measurement (SEM). Values of 0.5 x SD, or the value corresponding to an ES of 0.5, or 1.96 x SEM, have all been proposed to reflect the MIC. As these are solely statistical measures which do not take the importance from the patient's perspective into account, anchor-based approaches are preferred[64, 65]. Distribution-based calculations are nevertheless useful as supportive information. To combine the characteristics of both approaches, de Vet et al. developed an integrated method[66]; however, this visual method has not yet been used in populations with hand disorders.

MIC values are always determined in groups of patients (e.g. in an RCT or a longitudinal observational study), although this does not say anything about the level on which the MIC is applied[62]. It depends whether the anchor used for determining the MIC is on the group or individual level. An individual-focused approach applies in most clinical trials, which means that the MIC derived from a group of patients can be transferred to the individual[62]. The MIC is also

useful for calculating statistical power and determining sample sizes for a research project[64]. It varies across populations, disease characteristics, and treatments[64].

Apart from our study, there is one other study that has investigated the MIC of the MHQ[67]. Differences in the findings can be interpreted on the basis of different populations and the disparate methods used to calculate the MIC.

Future research should include a comparison of the MHQ with other hand specific questionnaires, such as the AUSCAN[68], PRWE[69], and Patient Evaluation Measure (PEM)[12], in order to find the best questionnaire for each purpose and target population. The calculation of the MIC for these questionnaires is useful to provide a number for sample size calculation and for the interpretation of treatment outcomes.

Patient satisfaction

Assessing patient satisfaction is becoming more and more important, because it contributes to the continuous evaluation of healthcare, for which the patient and society are paying[70]. Satisfied patients show greater compliance with treatment and an increased likelihood of returning to the same healthcare provider[12, 13]. Quantification is demanding because a variety of factors, as yet poorly defined, influence the patient's perception of a satisfactory outcome[12].

In order to identify which factors are associated with patient satisfaction following orthopaedic interventions in the hand, we reviewed the literature, as presented in **chapter five**.

The results indicate that a number of factors play a role in determining patient satisfaction; the hand surgeon or therapist can influence some of these factors, while others are beyond their control. The determinants revealed by this literature review could be effectively classified into the five categories of the ICF[42]. Factors in every category have an impact on treatment satisfaction, though most of them relate to body functions/body structures. This may be due to the fact that these factors are the ones most often studied while others such as environmental and personal factors have been less thoroughly investigated.

In reviewing the literature, we found that the appearance of the hand contributes to patient satisfaction. However, the studies investigated patients with rheumatoid arthritis[71, 72]. Based on the results of chapter four, where we found only a moderate effect size for the aesthetic subscale of the MHQ, we assume that the appearance of the hand is not such an important issue to patients with TMC OA as it is to patients with rheumatoid arthritis.

Strength and range of motion seem to correlate with patient satisfaction, although there is great diversity in the correlation coefficients. Chung and Hass[73] defined cut-off points for grip strength, key pinch strength, and range of motion related to satisfaction with these objective parameters after surgery for distal radius fractures. They found the cut-offs to be 65%, 87%, and 95%, respectively, of the function of the other, unaffected, hand. These findings highlight the importance of measuring objective outcomes and defining values to distinguish between satisfied and dissatisfied patients with any hand problem.

In the ICF category of environmental factors, we showed that patients who receive money during time of disability are less satisfied. Further studies also indicate that patients receiving worker's compensation were less satisfied with the results of a revision trapeziometacarpal joint arthroplasty[74] and had a higher risk of failure of partial wrist denervation[75]; the most influential predictor of pain and disability was third-party compensation[76].

When assessing patient satisfaction, it has to be remembered that several dimensions contribute to the individual perception of satisfaction. Satisfaction with the treatment outcome is only one aspect. Other aspects include facilities, service features, continuity of care, humaneness, competence, and the treatment process itself[12, 77]. Factors such as the friendliness of the staff[78-81], waiting times[79], time spent with the provider[79, 82], state of the facilities[81], and food[80, 81] have to be kept in mind, because they may also affect patient satisfaction. Furthermore, patient satisfaction is influenced by specific personal characteristics comprising expectations, demographics, and personal preferences[83].

Based on the results of this review, we recommend that treatment goals in routine practice should be the relief of pain or symptoms and restoration of the important individual functions, while taking the appearance of the hand into account. In addition, restoration of strength, range of motion, and deformity should be addressed. As well as evaluating these objective outcomes, consideration must be given to the impact of the patient's individual expectations and whether worker's compensation applies.

Further research needs to address the issue of assessing patient satisfaction. To date, satisfaction is measured using various approaches such as Likert Scales, visual analogue scales or the MHQ satisfaction subscale, which precludes statistical comparisons between studies. The focus should be on developing a standardised assessment tool for use in routine clinical practice.

Although we were able to identify several factors which might determine satisfaction in patients with various hand disorders, it was still not clear whether they were also true for patients with TMC OA. A retrospective study on patients after implant arthroplasty of the TMC joint, showed a correlation with satisfaction of $r > 0.7$ for pain, movement, strength, and ability to perform activities of daily living[84]. There is a lack of prospective studies investigating determinants of patient satisfaction after surgical and conservative management of TMC OA. In order to resolve this issue, **chapter six** evaluated determinants of patient satisfaction in the surgical and conservative treatment of patients with TMC OA.

The results of the cohort study revealed that patients' expectations play a major role in predicting satisfaction as the variable 'expectations fulfilled' was an important determinant of treatment satisfaction in both groups. These findings support the results of chapter five, where 'expectations met' has also been identified as associated with patient satisfaction.

In the field of hand surgery and hand therapy, evidence on the importance of expectations is still rare. Patients are often unaware of the severity of an injury and the complexity of treatment[85]. An association between expectations being fulfilled and patient satisfaction has been reported for patients after MCP arthroplasty[86]. It has also been shown that expectations being met and a general optimistic view of health accounted for 31% of the variability in postoperative DASH scores in patients after carpal tunnel release[87]. Our conclusion that patients are more likely to be satisfied if their expectations are fulfilled is confirmed in other studies on patients undergoing orthopaedic and abdominal surgery[88], patients seeking out-of-hours care[89], adults presenting a physical symptom[90], and patients with total hip and knee arthroplasty[91, 92].

In contrast to expectations fulfilled after the intervention, the relevance of the preoperative expectations in hand surgery has not been demonstrated to date[87]. Research on expectations in patients with other musculoskeletal conditions found that positive expectations of the

outcome predicted a favourable outcome and higher satisfaction, whereas negative baseline expectations were associated with a worse outcome[93].

The association between expectations and satisfaction substantiates the relevance of the decision-making process prior to an intervention. Detailed patient education about the injury and the resulting intervention may lead to better adherence to treatment[85]. In areas other than hand surgery and therapy, it has been shown that the information given to the patient and shared decision making can have a positive effect on patient satisfaction[81, 90, 94].

Based on these results, we can conclude that expectations being fulfilled is an important determinant of treatment satisfaction. It highlights the need to evaluate expectations and to provide patients with comprehensive information prior to the intervention, so that their expectations of the treatment outcome are realistic.

As mentioned previously, further research needs to address the issue of assessing patient satisfaction, as well as evaluating individual expectations. Whenever expectations are measured at the present time, which is rarely the case, different non-standardised tools are used for surveying baseline expectations and evaluating their fulfilment. This variety of outcome measures precludes statistical comparisons between studies. The focus should be on developing a standardised assessment tool for routine use in clinical practice to evaluate patients' expectations prior to treatment and to determine their fulfilment and satisfaction when treatment is finished.

Clinical outcomes in the treatment of patients with TMC OA

Besides the determinants for satisfaction, **chapter six** analysed the outcomes of surgical and conservative treatment in patients with TMC OA. The results of this cohort study showed that patients treated conservatively had fewer complaints at baseline and a less advanced stage of OA than patients who had been operated on. Conservative treatment seemed to be most effective in the first six months. Other studies reported similar results: patients with stage I or II TMC OA benefitted more from conservative treatment, and for a longer period, than patients with more severe TMC OA[95, 96]. The effects of a steroid injection in patients with TMC OA stage I or II have been found to last from 4 to 18 months[95, 96]. These findings also support our regression analysis results showing that conservatively treated patients with a more advanced Eaton stage of OA seem to be less satisfied with the treatment result. Conservative treatment, including nonsteroidal anti-inflammatory drugs (NSAIDs), physiotherapy, analgesics, splints, and intra-articular corticosteroid injections, has not been shown to have any long-term effectiveness[95-97].

The decision on the treatment strategy for our patients was made individually in each case. Our surgeons usually prefer to treat patients with only mild complaints conservatively but suggest surgery to patients with severe pain and restrictions in daily life. This approach is confirmed by other researchers, who recommended surgery in cases where pain restricts the patient's daily life or when conservative treatment fails[14, 97, 98]. However, steroid injections might be useful in patients severely affected by TMC OA, in order to reduce the symptoms while waiting for surgery[95, 97, 98].

In the surgical group, hand function measured with the MHQ showed a significant improvement of 31 points between baseline and 1 year. As this change is above the value for the MIC of 17 points[99], we can assume that this result is not only statistically significant but also

clinically meaningful for the patients. Similar changes were found for patients after abductor pollicis longus suspension arthroplasty[100] and after basal thumb metacarpal osteotomy[101], with patients in the latter study improving by 28 points after three years. This result indicates that the outcomes of surgery for TMC OA remain stable with time.

Based on these results, we can conclude that patients with mild complaints may benefit from conservative treatment with an effect lasting about six months. We suggest surgery in cases where pain limits the patient's daily life or when conservative treatment fails.

Further research is needed to compare different surgical treatment strategies. Although trapeziectomy with ligament reconstruction and tendon interposition (LRTI) is the first choice of 2/3 of American hand surgeons[102, 103], there is limited evidence for the superiority of that technique in terms of pain reduction and restoration of hand function[37, 104, 105]. Some studies suggest that trapeziectomy alone results in fewer adverse events than trapeziectomy with LRTI[37, 104, 105]. It still has to be confirmed whether LRTI produces better long-term results because the scaphoid-metacarpal distance is preserved[105]. In addition, the development of an algorithm to identify patients who would benefit from conservative management or from surgery would be useful to assist in making the medical decision prior to an intervention.

Economic aspects

Economic aspects in the treatment of TMC OA were investigated in **chapter seven**. In medicine, the effectiveness of interventions has traditionally been evaluated in terms of mortality, clinical aspects, and patient-related outcomes[106, 107]. In recent years, however, outcome measures have expanded to include economic analyses, due to the increasing costs of healthcare combined with the costs for the employers. Expenses for the employer arise from absenteeism, short-term disability, long-term disability, worker's compensation, and presenteeism[106, 107]. Presenteeism, i.e. reduced productivity at work due to health problems, is not only an issue for employers but also for the workers. From their perspective, going to work when not feeling well is important because it might exacerbate existing medical conditions, reduce the quality of working life, and lead to an impression of inefficiency due to reduced productivity[107]. On the other hand, loyalty to the employer may encourage people to go to work when they are not feeling up to it and can be regarded as productive gain instead of loss due to absenteeism[107].

In contrast to absenteeism, the quantification of presenteeism is complex[106]. Several instruments to measure the impact of illness on productivity have been developed and reviewed[106, 108-112]. Although most of these tools provide sound measurement properties, all of them have some shortcomings[106]. Some of the questionnaires were developed for a specific health condition and are not transferrable to other diseases. Others are intended to be used in clinical settings and are therefore useless for employers. The major issues concern scoring the questionnaires, converting the answers into a usable construct such as lost time, and translating the scores into monetary values[106]. For some questionnaires, such as the WPAI[113] that we used in the work described in **chapter seven**, the answers are easily convertible into figures for absenteeism and presenteeism. Answers to other questionnaires, however, cannot be converted directly or the conversion methods have not been published[106]. Due to the variety of outcome measures and translation methods, research results cannot be compared between different studies at the present time. Awareness of the methods is therefore important when interpreting study

results. The subsequent translation of figures for presenteeism to monetary values can be based on different economic models, such as the human-capital method or the friction-cost method. However, there is no general consensus as to which model is the best. Researchers should be clear and transparent about how they measured presenteeism and how they converted and translated it into monetary values[106]. They are also encouraged to consider the target concept and the purpose of the intended application, as well as the underlying economic model[106, 109].

In the WPAI, presenteeism is calculated by using the answer to question 5 ("How much did your TMC OA affect your productivity while you were working?"). If patients give a score of 8 out of 10, would that necessarily mean that they are only able to work 20%, leading to a 80% loss for the employer[111]? This might be true for some jobs, but it is unlikely in others[111]. The costs of presenteeism may therefore generally be overestimated, something that has also been indicated in a study including patients with rheumatoid arthritis[114].

In **chapter seven**, we found a large difference in total annual costs between surgical and conservatively treated patients, but we cannot make any firm treatment recommendations based on these results. The indications for injection therapy and surgery are different, and any such recommendations have to consider both the clinical and subjective outcomes. In **chapter six**, we found significantly better outcomes for surgical patients than for those treated conservatively.

Bearing in mind both the outcomes and the economic aspects, cost-effectiveness or cost-utility analyses are useful for making treatment recommendations. In these types of study, the costs of two (or more) interventions are put in relation to the clinical outcomes or utility measures, respectively[115]. Utilities are usually expressed as quality-adjusted life-years (QALYs) which can be derived from quality of life questionnaires, such as the SF-36 or the EuroQol-5D (EQ-5D)[115]. It was not worth performing a cost-utility analysis with our patient population, because the two treatment groups were not comparable with respect to either indications or outcomes.

Future studies, preferably with a randomised design, should include economic analyses. It is useful to compare different surgical treatment options with each other or with different conservative strategies. If the indications for the different treatment options are equal, cost-utility studies may assist the healthcare provider to choose the best treatment for the patient, bearing in mind the economic consequences. Ideally, a cost-utility study would also include other healthcare costs, such as those incurred for drugs, physiotherapy, assistive devices, nursing services, and visits to other doctors. The cooperation of health insurers would be required to access the relevant data. Further research should also assess the accuracy and usefulness of different tools in specific settings[108]. Standard presenteeism metrics need to be defined, in order to allow the comparison of study results[111].

CONCLUSIONS

This thesis investigated different aspects relevant to patients with hand OA: patients' limitations in daily life, outcome measures, and treatment outcomes, focussing on patient satisfaction as well as economic aspects.

Regarding limitations in daily life, it can be concluded that patients report severe restrictions, in particular in opening food packaging. In order to make life easier for patients in the future, we defined guidelines for the industry on the production of easy-to-open food packaging.

A systematic literature review of outcome measures for patients with TMC OA found that numerous patient-reported outcome measures are used at present. None of them show overall positive ratings with respect to measurement properties, which is partly due to the lack of methodologically sound studies. In an observational study, we were able to show that the MHQ demonstrates good reliability, validity, and responsiveness in patients with TMC OA and we recommend it as a suitable assessment tool in this population.

With respect to satisfaction, many variables determine patient satisfaction with treatment; relief of pain or symptoms and the restoration of hand function are the most important determinants in patients with orthopaedic hand conditions. In patients with TMC OA, it was found that expectations being fulfilled was an important determinant of treatment satisfaction. Giving patients comprehensive information prior to the intervention is of the utmost importance to ensure that their expectations of the treatment outcome are realistic.

Evaluation of the outcomes of conservative and surgical management in patients with TMC OA showed that surgery leads to significantly improved hand function after one year, while conservative treatment seems to be most effective in the first 6 months. These results suggest that patients with mild complaints benefit from conservative treatment, with the effects lasting about 6 months. Surgery is indicated in cases where pain limits the patient's daily life or when conservative treatment fails. From an economic point of view, however, surgery is associated with considerably higher costs than conservative treatment, with respect to both healthcare costs and loss of productivity.

In medicine, the doctor-patient relationship enters an important dimension when evaluating treatment performance. The use of validated outcome measures should be mandatory for assessing any form of treatment, whether surgical or conservative. The results will further enhance the close interrelationships between patients and their healthcare providers.

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