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Virtual goniometric assessment of finger motion: commentary and personal opinion

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Introduction

Following an injury, the purpose of any hand assessment is to evaluate the status of the injury in terms of wound healing, swelling, scarring, active range of motion (AROM), passive range of motion (PROM), sensation and strength. This assessment is a prerequisite for having an in-depth understanding of the extent of upper extremity injury and determining the appropriate therapeutic intervention. In addition, hand assessment allows us to measure the effect of management and monitor the ongoing status of the individual's improvement of hand function. This information obtained can also be used for professional communication with various health care providers and to identify outcomes for research. In terms of measurement parameters, goniometric evaluation is just one, but an important aspect of evaluation performed by the health care team to determine the status of the muscles, joints and/or combination of both. Digital mobility is significantly dependent on proximal joint motion; therefore, a thorough screening of proximal joint motion and strength gives clinicians a clearer understanding of the limiting factors due to the injury.

To prevent the spread of COVID-19 infections, hand clinics globally stopped one-on-one patient visits for nearly 3 years (Herren et al., 2022). Health ministries around the globe determined the appropriateness of acceptable service delivery with limited, or minimal human interaction. Health-care professionals relied on follow-up telephone or video calls to review patient status. Various other forms of virtual platforms for such services were developed by defining appropriate standards of care to assess and manage patients following injury. However, some aspects of assessment that are more hands-on, such as palpation to evaluate tissue status and accurate goniometry measurements, could not be performed on these virtual platforms at that time. Moreover, some patients either did not have access to the virtual technology or were not comfortable using the platforms. Other interventions, such as PROM, joint mobilization and/or the fabrication of dynamic or static progressive splints, were also not possible. It was during this time that several advances in virtual assessment methods of measuring joint range of motion (ROM) objectively took place to provide patient care despite the pandemic environment.

I compliment the authors of the article 'Inter-rater and intra-rater reliability of finger goniometry measured from screenshots taken via video consultation' (Johnson et al., 2022) for studying the accuracy of virtual ROM measurements. Taken by goniometric measurements from screenshots on actual digits, the authors recruited three volunteer 'subjects' for their study who were evaluated by 27 therapists. It is unclear from their description whether the joint measurements were taken in extension and/or flexion. Tables 1 to 3 in the article did not clearly specify the ROM describing the starting to the ending position of the joint and I gathered from reading this article, that only one static position was used for measuring the joint range of motion. However, the authors conclude that the goniometric measurements taken from the screenshots are reliable with a moderate to excellent inter- and intra-rater reliability between therapists and that this method of evaluation could be used remotely during video consultation. This article is helpful in reassuring clinicians that despite some drawbacks, ROM measurements can be reasonably reliable when assessed remotely using a low-cost option, providing a standard protocol is in place.

The article 'Precision and accuracy of measuring finger motion with a depth camera: a cross-sectional study of healthy participants' (Lv et al., 2022) provided another perspective for measuring finger ROM. Using a depth camera, the authors reported that their normal subject study population demonstrated a large variation in repeatability and reproducibility in flexion when compared with the measurements in extension. With traditional goniometry, variations of ROM at the metacarpophalangeal (MCP) joint is usually less than the interphalangeal joints, and this was in line with the findings of this study that MCP joint measurements as produced by the depth camera are

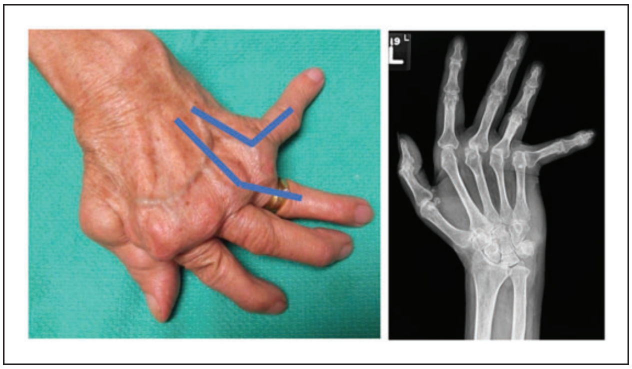

Figure 1. Measuring wrist and hand deformities in rheumatoid arthritis. In this classic case of rheumatoid hand, showing wrist and carpal arthritis and MCP joint subluxation, mapping of the positions of the metacarpal and proximal phalanx to assess angulation at the MCP joints may be necessary before capturing ROM.
MCP: metacarpophalangeal; ROM: range of motion.

more reliable when compared with the interphalangeal joints.

Upon reviewing both these articles, the methodology and conclusions derived by the authors suggest that there exist methods that are overall appropriate for assessing the ROM of a joint remotely. The importance of these studies, in the changing nature of our practice due to the pandemic, should not be underestimated. Moreover, further research avenues are created where we further refine the use of these remote technologies.

The purpose of measuring joint ROM could be for clinical diagnoses and/or for research. For example, in a clinical setting AROM and PROM measurements are taken to identify the responsible structures restricting movement, which may include either a capsular or tendinous pathology. Further to aid in clinical diagnoses, the position of the wrist,

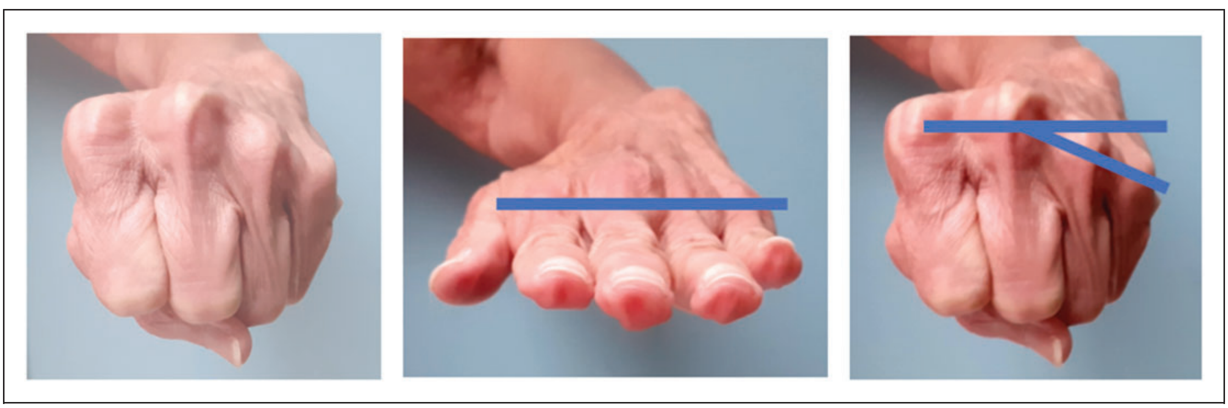

Figure 2. Measurement of CMC joint convergence of the ring and little fingers. The motion occurs at the CMC joint and the rotation of the metacarpal heads occur at the transverse metacarpal ligament distally. These measurements are affected as a result of ulnar nerve palsy, metacarpal neck and shaft fractures, dorsal capsular and collateral ligament contractures following various pathologies and fracture dislocations of the CMC joints.
CMC: carpometacarpophalangeal.

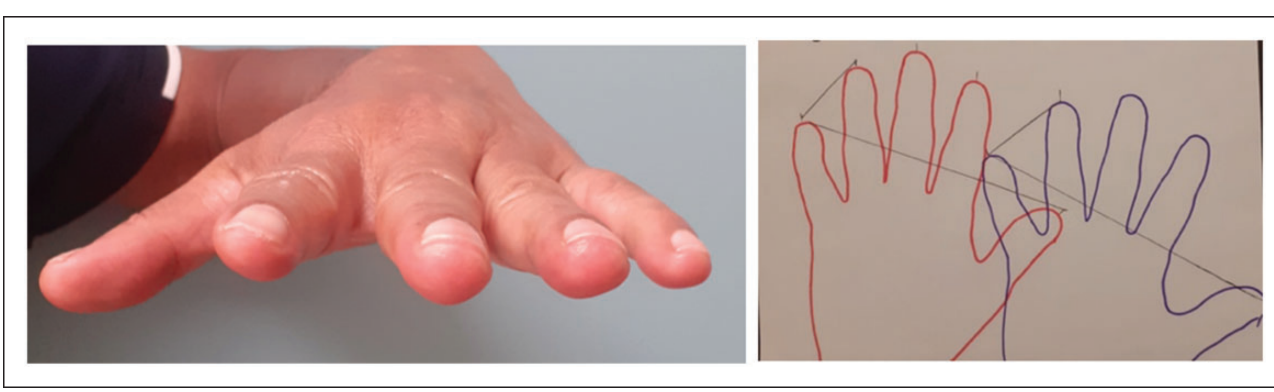

Figure 3. Assessment of finger and thumb abduction. In addition to the range of motion, linear distance finger abduction measurement is essential to assess (1) the span of the fingers and thumb and (2) intrinsic muscle's ability to abduct the fingers. Finger and thumb's ability to abduct is often affected by various pathologies and thus recording of these linear measurements is essential. Documentation of improvement and interventions are necessary to increase digital abduction.

MCP and proximalinterphalangeal (PIP) joint may be necessary to further understand the nature of joint motion restriction. Also, for clinical outcome measures, a comparison of total active motion (TAM) and total passive motion (TPM) would give a truer picture of the injured patient's status. This information is clinically essential for planning a precise therapeutic intervention programme. Therefore, in my opinion, the measurement of joint ROM, whether taken by screenshots and/or by depth cameras, may not reveal the exact nature and extent of 'true patients' limitations of the joint and would need to be supplemented by further information as mentioned above.

Figure 4. Measurement of MCP joint hyperextension affecting PIP and the DIP joints. MCP joint hyperextension occurs as a result of (1) ulnar (severe) and median nerve (mild) injuries, (2) PIP joint flexion contractures and (3) PIP joint extensor lag. These are due to various injuries to the hand and thus recording of this measurement and specific documentation of the cause of MCP joint hyperextension could be measured from the medial side of hand.
MCP: metacarpophalangeal; PIP: proximalinterphalangeal; DIP: distalinterphalngeal.

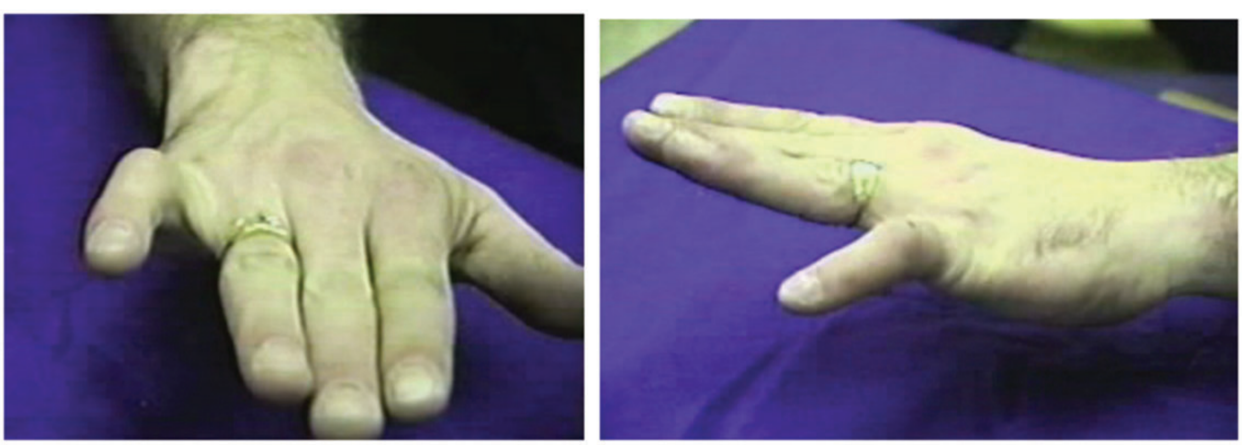

Figure 5. Little finger abduction, hyperextension and rotation at the MCP joint during extension and scissoring of the finger during flexion. The entire pattern of small finger motion changes when the PIP joint has an extensor lag or the PIP joint flexion contractures. The proximal phalanx hyperextends, abducts and rotates at the metacarpophalangeal joint. The reason for this is because of the greater dorso-ulnar articular configuration on the little finger metacarpal head. As it is the proximal phalanx, this has a continuous tendency to hyperextend due to the combined vectors of the central slip dorsally and the flexor digitorum superficialis volarly. During extension of the little finger, in the presence of an extensor lag at the PIP joint or flexion contracture, the combined vectors of extensor digitorum communis, extensor digiti minimi and the abductor digiti minimi produces MCP joint hyperextension, abduction and rotation of the proximal phalanx over the metacarpal. Overtime, some adaptive shortening of the capsulo-ligamentous structures alters the patten of finger flexion. In such situation, finger abduction, hyperextension and the rotation of the proximal phalanx is difficult to assess using traditional goniometric measurements.
MCP: metacarpophalangeal; ROM: range of motion; PIP: proximalinterphalangeal.

In our own experience with using virtual platforms for hand assessment we had encountered several limitations, such as patient's understanding on the instructions, positioning the hand in the centre of the camera frame, sharp focus of the image and appropriate lighting conditions to visualize the position of the fingers. Similar limitations were also expressed by various clinicians where the accuracy of evaluation and treatment recommendations and prescriptions appeared to have a questionable match. Figures 1 to 5 describe some case examples where discrepancies may arise due to the clinical nature of the condition.

As virtual platforms become more popular, we hope to see many improvisations and improvements of these platforms over the years. But even if we can accurately measure the ROM remotely, we will still need a human touch to identify the cause of limitation, as to whether this is caused by extrinsic or intrinsic tightness, whether the joint stiffness is due to capsular or ligamentous tightness or if there is shortening and/or adherence of musculotendinous structures. The pursuit of better ROM measurements should continue, however, all these manual assessments do provide clues in defining the joint motion limitation and are important parameters in determining the most appropriate therapeutic intervention needed. In addition, they allow periodic reassessments to identify progress and to set new intervention goals, allowing therapists to monitor progress 'in-between' physical visits.

Conclusions

Despite our continued efforts in improving hand evaluation techniques, we will continue to face some limitations in quantifying measurement of joint motion to exact precision, even when assessed in-person. The future is exciting as we explore options and technologies to combine both remote and in-person assessments of our patients. As pandemic-related restrictions continue to be reduced, the use of virtual platforms for clinical practice have also been reduced; however efforts should be continued to retain these platforms while modifying and enhancing them for future occurrences where we will need this technology. They are also extremely useful for patient care to reach those who live in remote areas or who are unable to travel to see us in person, for whatever reasons.

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References

Herren D, Verstreken F, Lluch A, Naqui Z, van der Heijden B. The impact of COVID-19 pandemic on hand surgery: a FESSH perspective. J Hand Surg Eur. 2022, 47: 562–7.
Johnson D, Barradas R, Newington L. Inter-rater and intra-rater reliability of finger goniometry measured from screenshots taken via video consultation. J Hand Surg Eur. 2022: 1–6.
Lv L, Yang J, Gi F, Fan J, Zhu Q, Liu X. Precision and accuracy of measuring finger motion with a depth camera: a cross sectional study of healthy participants. J Hand Surg Eur. 2022: 1–7.

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