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Exercise relative motion orthoses: Use of the pencil test and variations of its use for assessing and managing different finger conditions

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While initially intended to protect extensor tendon repairs,[1] evidence is emerging to support use of relative motion (RM) orthoses for exercise.[2-5] To be categorized as an RM orthosis a differential angle between the metacarpophalangeal joints of the injured and uninjured digits must be maintained throughout the range of finger motion.[6-10]

Exercise RM orthoses are defined by their purpose that is, to redirect active forces and/or block motion.[5-11] For example, a relative motion flexion (RMF) orthosis can address a proximal interphalangeal joint (PIPJ) active extension lag by blocking the metacarpophalangeal joint (MCPJ) in flexion and conveying extrinsic and intrinsic muscle forces to promote PIPJ extension.[11] Another example is using relative motion extension (RME) orthoses to block full MCPJ flexion and redirect forces towards improving PIPJ flexion.[5]

The simple, low-profile design of RM orthoses supports hand function very well after finger extensor tendon repair.[1,12,13] Wear of exercise RM orthoses during functional tasks can also support the goals of therapy through non-intentional exercise. When employing RM orthoses for exercise the following should be considerd: (1) timing of orthotic implementation, (2) orthotic design, (3) dosage that is, frequency and duration of orthotic wear, and (4) timing of orthotic modification or discontinuance. This article aims to offer guidelines for therapists implementing RM orthoses for the purpose of exercise.

Clinical application of exercise RM orthoses

Goniometer assessment

Although evidence is limited, exercise RM orthoses may yield better results if the targeted joint has more passive than active motion.[5] We recommend initial baseline and follow-up active and passive goniometric measurements to monitor progress of the therapy intervention, which will also serve to confirm the clinical condition.

Pencil test assessment

Originally described by Merritt[6] using a sterile tongue depressor blade the term 'pencil test' was later coined by Lalonde[14] and advocated by others[11] as a method to determine if the differential MCPJ angle created by the pencil produces the desired response. The pencil test is executed by weaving a pencil (or pen or tongue depressor/flat sticks) between the fingers placing the MCPJ of the affected finger in RME or RMF, asking the patient to perform the desired motion, and then measuring the angles of the involved and

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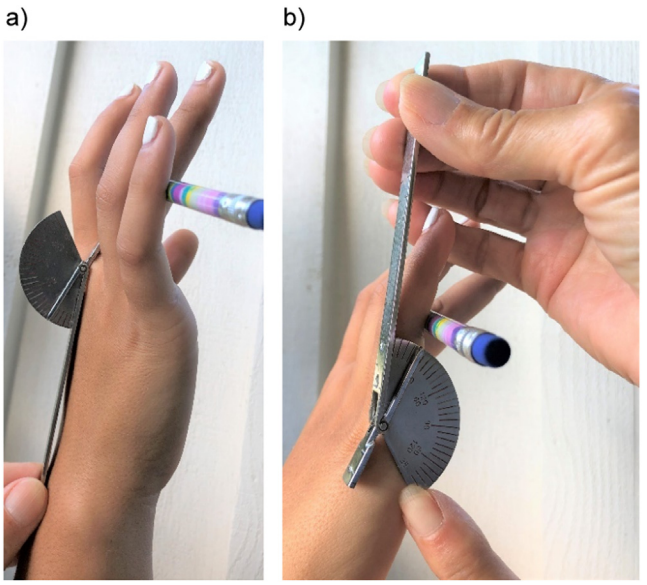

Fig. 1. Pencil Test in relative motion flexion (RMF) of the long finger while measuring MCPJ flexion (25° flexion), and b) goniometer measurement of the small ring finger MCPJ (hyperextension 20°) for calculating the differential angle of (45°).

adjacent MCPJs. The difference between the two measured angles is the MCPJ differential angle. Fig. 1 illustrates the RMF pencil test with the involved and non-involved MCPJs being measured to calculate the MCPJ differential. If the desired motion is less than expected for the specific condition, the diameter of the pencil pen or flat sticks can be adjusted by modifying the pencil/pen or layers of flat sticks and repeating the test. Once the MCPJ differential angle is established the next step is to again use the goniometer to measure active and/or passive range of motion of the joint(s) targeted for exercise. For some conditions a thermoplastic RM orthosis is not always required; for other conditions, a pencil, pen or flat stick or contralateral finger is sufficient for home exercise, while a soft exercise RM orthosis may be adequate for other clinical conditions.[15] (*Refer to Feehan/Ewald article in this issue*). Fig. 2 is an algorithm to guide pencil test assessment and guide use of a thermoplastic or soft orthosis or pencil/pen/flat stick(s)/finger to create the best MCPJ differential angle for exercise.

Limited passive MCPJ extension

To assess, apply the RME pencil test by placing the involved MCPJ in more extension than the adjacent MCPJ. With the pencil in place, allow a few minutes to observe the patient's response to this more extended MCPJ position. Increase the differential angle serially for more passive stretch by increasing the pencil diameter (Fig. 3) duplicating this in the fabrication of the RME orthosis. Potential reasons for *limited passive MCPJ extension* might include volar capsular or extra-capsular restriction, intrinsic muscle tightness, flexor tendon adherence or trigger finger.

Limited passive MCPJ flexion

To assess, use the RMF pencil test by placing the involved MCPJ in more flexion than the adjacent MCPJs and serially increase the differential angle by increasing the pencil's diameter and adjusting the degree of passive tension as comfortable for the patient (Fig. 4**).** Causes may be limitations of the dorsal MCPJ capsular or extracapsular structures or extensor tendon adhesions.

MCPJ active extension lag

Adhesions of the long extensor tendons or inadequate muscle performance may result in *more passive than active* MCPJ extension. Use the RME pencil test to assess the differential angle required to yield the most active MCPJ extension (Fig. 5). As the extensor lag improves, repeat the RME pencil test with a smaller diameter pencil while observing the effect on active MCPJ extension, and then make the necessary adjustments to the orthosis. In some cases, buddying the involved with an adjacent finger may improve active MCPJ extension and by leaving the RME orthosis loop open, finger extension will not be blocked.

Blocking MCPJ or PIPJ flexion

Clinical conditions that may benefit from an exercise RME orthosis to block MCPJ motion to convey flexion forces to the interphalangeal joints (IPJ) flexion include: tight intrinsic muscles, stiff IPJ or excessive MCPJ mobility (notably of the ulnar digits). Use of the orthosis to partially block PIPJ motion directs flexion forces toward the motion-limited MCPJ or distal IPJ. It is important to distinguish if loss of passive PIPJ extension is due to PIPJ contracture as the orthosis may not be helpful. In Fig. 6 the RME pencil test has been modified to partially block MCPJ flexion. The RME orthosis is designed wider under the involved finger to block full MCPJ or PIPJ flexion.

PIPJ active extension lag

A challenging and common condition after injury is an extension lag of the PIPJ that is, *passive exceeds active* PIPJ extension. This may be the consequence of adhesions after extensor tendon injury/fracture or PIPJ trauma. Conceptually the RMF pencil test position (Fig. 7) is believed to rebalance the extrinsic and intrinsic muscles to improve active PIPJ extension.[11,16,17] As PIPJ extension improves, modify the pencil's diameter to maximize active motion. Patients with active and passive PIPJ limitations of 20°or less have been reported to be corrected by wearing the RMF orthosis.[15]

Orthotic design

The decision to fabricate a 3- or 4-finger RM orthosis centers on the lifestyle requirements of the patient and constructing a biomechanically effective orthosis.[1,5] Biomechanics of the pencil test and orthosis often improve when all 4 fingers are included and (1) the adjacent finger is put in the same position as the involved finger and, (2) for balancing the orthosis when managing a border digit.

Timing, dosage and task-specific wear of exercise RM orthoses

There is limited evidence regarding timing of intervention and the most effective orthotic wear dosage. Authors of two different reports[2,3] introduced exercise RM orthoses three weeks following finger fracture, while a third report of patients with established PIPJ limitations implemented orthotic wear six weeks post injury/surgery.[5] One group wore RMF orthoses five times per day for exercise[3]; the second had no dosage described[2], while the third was instructed on orthotic wear during the day for functional tasks.[5] With limited evidence, we suggest use of clinical judgment to determine intervention timing and dosage.

There is clear evidence that the low profile and small size of finger-based RM orthoses supports hand function after extensor tenorrhaphy.[12,13] Patient-report in one study prescribing exercise RM orthoses informed researchers that participants often removed their orthosis for daily activities.[5] To support therapy goals, patient

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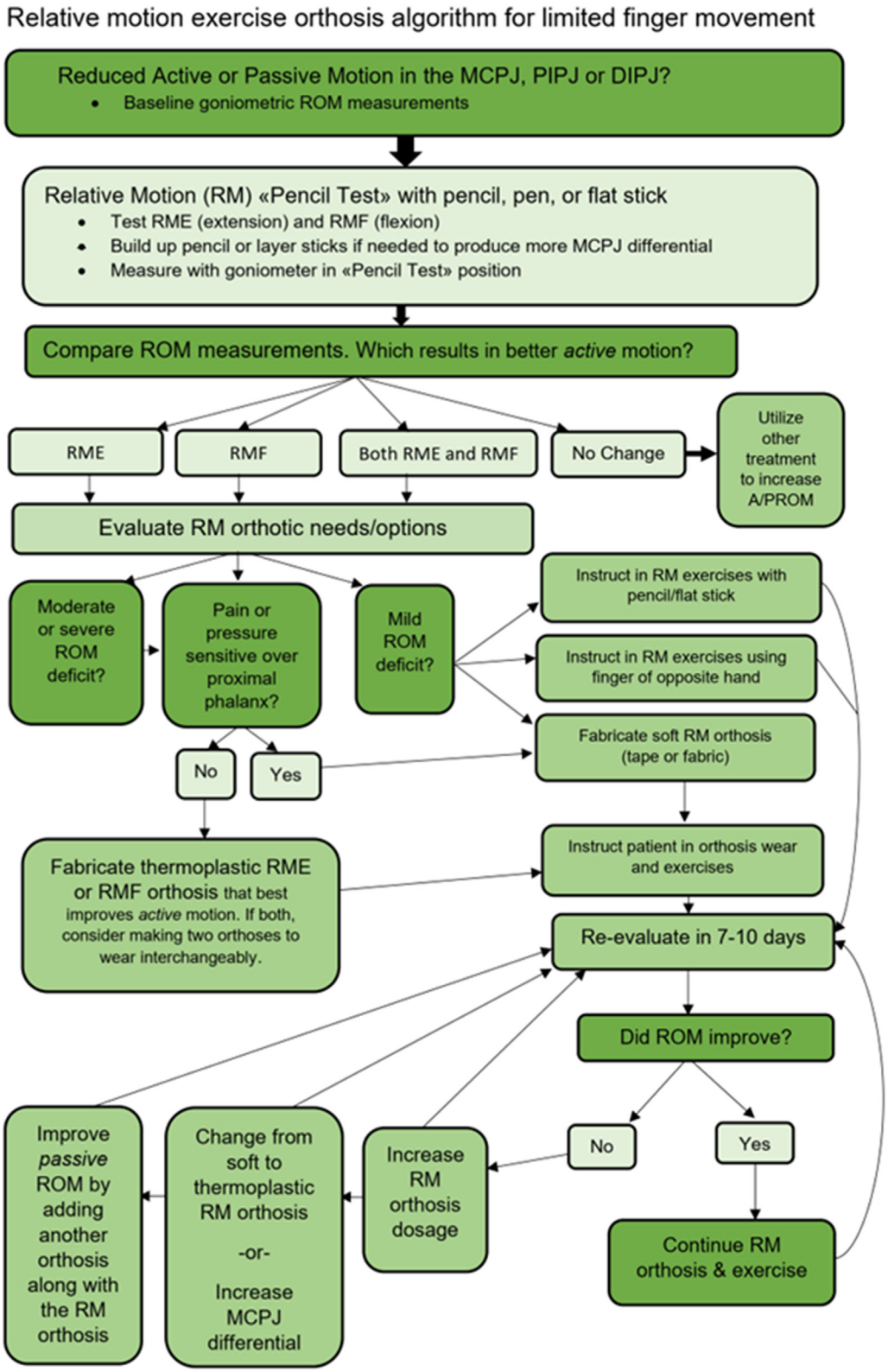

Fig. 2. Algorithm to guide use of the Pencil Test for assessment of resultant finger joint range of motion and to determine which achieves the best response, a thermoplastic or soft orthosis or pencil/pen/ flat Fig. 2 Key. MCPJ-metacarpophalangeal joint, PIPJ-proximal interphalangeal joint, DIPJ distal interphalangeal joint, ROM- range of motion, A- active, P-passive stick/finger.

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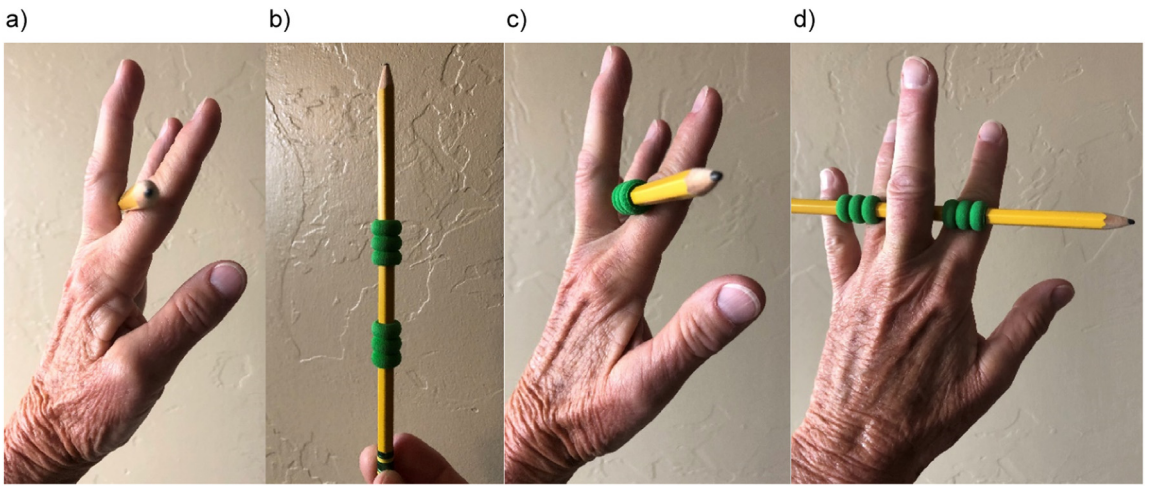

Fig. 3. a) Relative motion extension (RME) pencil test for long finger, b) modification of pencil to increase the pencil's diameter to increase the MCPJ differential angle, and c) RME pencil test with the modified pencil increasing the differential angle between the long finger MCPJ and other finger MCP joints.

Fig. 4. Clinical condition: limited *passive* flexion MCPJ small finger. RMF Pencil Test small finger buddied with ring finger.

Fig. 5. Clinical condition: *active* extension lag MCPJ long finger RME pencil test. a) MCPJ at end range passive MCPJ extension and *no active* MCPJ extension and b) an increase in the MCPJ differential angle enables *active* long finger extension.

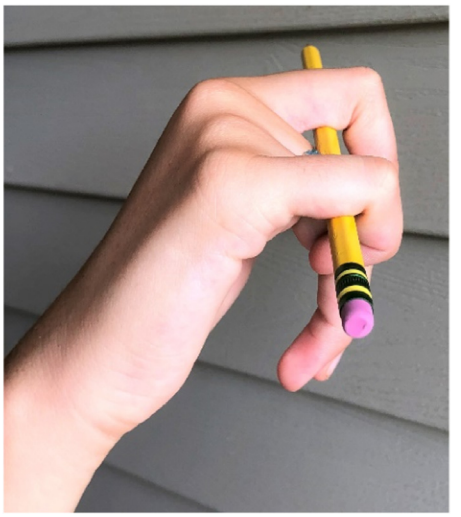

Fig. 6. Clinical condition: excessive flexion MCPJ small finger. RME Pencil Test small finger blocks excessive MCPJ motion to relay active flexion toward PIPJ. The index finger is also in relative extension to balance the pencil. (Note: the long finger could also balance the pencil to simulate a 3-finger RME orthosis)

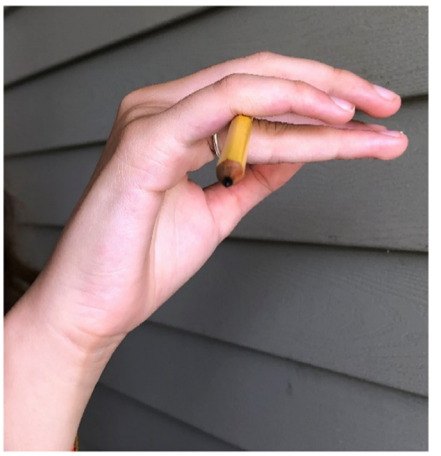

Fig. 7. Clinical condition: *active* extension lag PIPJ ring finger. RMF Pencil Test to balance intrinsic-extrinsic muscle forces to improve active PIPJ extension.

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understanding of the role exercise RM orthoses play through non-intentional exercise is key.[5]

Summary

The authors have provided guidelines and a decision-making algorithm for implementation of exercise RM orthoses based on specific clinical conditions, goniometric measurements, and variations of the pencil test as a tool for assessment and exercise.

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