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Intra-Rater and Inter-Rater Reliability of the Mobil-Aider® Device for Measurement of Linear Translation: Implications for Clinical Practice and Teaching

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Abstract

Orthopedic Manual Physical Therapy (OMPT) has not enjoyed an abundance of evidence supporting its efficacy. Skill acquisition in the performance of manual interventions requires the development of new patterns of motor performance. Feedback and practice time have been identified as the most important variables in skill acquisition. The Mobil-Aider® provides feedback in a timely and precise fashion and may be helpful in the development of new psychomotor skills.

The purpose of this study was to assess the intra-rater and inter-rater reliability of the Mobil-Aider® in measuring linear translation during posterior glides of the shoulder and volar glides of the wrist in healthy, unimpaired participants within two independent investigators.

A posterior glide of the shoulder was performed in supine with a mobilizing wedge stabilizing the scapula. For the wrist, a volar glide was performed in sitting with the forearm supported in pronation. For both mobilization techniques, a series of three Grade IV accessory glides were performed.

There were 32 participants (16 males, 16 females) with a mean age of 24.81 years. For the shoulder: Intra-rater reliability was 0.691 (good) for investigator 1 and 0.789 (excellent) for investigator 2; inter-rater reliability was 0.546 (fair). For the wrist: intra-rater reliability was 0.932 (excellent) for investigator 1 and 0.917 (excellent) for investigator 2; inter-rater reliability was 0.462 (fair).

These results have implications for assessment of joint mobility in clinical practice by establishing the reliability of a device designed to quantify joint linear translation. This device may be useful during examination in providing objective data that can be used to identify mobility deficits and objectify changes in response to joint mobilization procedures. Further, these results may also provide important data used to guide the application of joint mobilization by serving to standardize the quantity of joint translation associated with a specific mobilization grade. This will improve the consistency with which joint mobilization is performed.

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Introduction

Evidence Based Practice (EBP), as defined by Sackett is using the best available evidence in combination with each patient's individual values coupled with the experiences and expertise of the clinician [1]. In this way, EBP informs clinical decisions but does not mandate them. Historically, Orthopedic Manual Physical Therapy (OMPT) has not enjoyed an abundance of evidence supporting its efficacy. Within OMPT, the process of decision-making is often interactive in that the choice of what to do next is based on the patient's immediate response to the prior intervention. This process makes it challenging to establish reliability for a particular procedure that can account for the degree of variation that exists between patients. Much of the current practice of OMPT has been passed down through authoritarian pronouncements rather than evidence gleaned from well-constructed clinical trials [2].

Inter-rater reliability is defined as the extent to which two or more investigators or clinicians reach agreement in a defined parameter. Decisions regarding clinical care based on measures that do not possess sufficient inter-rater reliability should be avoided. However, this does not necessarily mean that interventions that relate to these measures should not be used. In the lumbar spine, for example, reproducible measurement of segmental mobility has not been achieved in the literature [3-6]. Despite disagreement regarding the relative degree of segmental motion loss, spinal manipulation has been found to be a safe and effective intervention strategy for individuals with low back pain [7].

The term "psychomotor skill" is used when describing the manual interventions provided by a physical therapist for the purpose of highlighting both the cognitive and motor aspects of these tasks [8]. In addition to the cognitive processes that are required to inform clinical decisions, skill acquisition in the performance of manual interventions also requires the development of new patterns of motor performance. For this reason, these skills are often underdeveloped in novice physical therapists, thus leading to inconsistent performance or a reduction in the utilization of these procedures in clinical practice. Flynn et al. [9] revealed that students who were trained in evidence-based decision-making and psychomotor skill acquisition were inclined to utilize these procedures more frequently and in a manner that was more consistent with best practice guidelines.

Furthermore, feedback and practice time have been identified as the most important variables in skill acquisition [10]. Typical strategies for teaching manual skills involve instructor demonstration followed by learner practice with qualitative feedback from the instructor that is often provided at a distance and in a delayed fashion. Evidence suggests that performance of a motor task may degrade if knowledge of performance is not precise, or if practice is delayed [11,12]. Delays between performance of a task and feedback may also negatively impact skill acquisition [13]. Intrinsic feedback is provided by sensory systems during the performance of a motor task and is inherent to the task as opposed to extrinsic feedback, which is supplementary to the task and provided by an instructor or external device [14]. In summary, feedback that is provided in a timely and precise fashion is imperative for the development of new psychomotor skills. The challenge of providing precise feedback for individuals who are learning manual skills pertains to the small degree of relative motion elicited and the difficulty associated with quantifying these motions. New strategies for facilitating intrinsic feedback, in which the novice learner is engaged in an ongoing feedback loop consisting of application-assessment re-application-reassessment, while performing a motor task are necessary. Another instructional model, involving four steps as developed by Peyton, has been shown to be effective in the acquisition of manual skills. These steps include 1) demonstration, in which the instructor performs the task at normal speed, 2) deconstruction, in which the instructor repeats the task more slowly while describing each component during performance, 3) comprehension, in which the instructor repeats the task while the student provides verbal guidance and, finally 4) performance, which involves the student performing the task independently [12,15,16].

Joint mobilization for improvement in accessory motion

Maitland defines mobilization as passive movement that is performed with a defined rhythm and grade [17,18]. Paris contends that the terms mobilization and manipulation are identical in meaning and thus can be used interchangeably; they are described as the "skilled passive movement to a joint" [19].

The current best evidence supports the use of joint mobilization techniques to improve linear translation and overall joint mobility [20]. However, the development of skilled performance of these procedures may be challenging and standardization of linear translation during their performance is difficult to quantify. The importance of consistency in measuring linear translation as it pertains to clinical practice and teaching and learning psychomotor skills is self-evident.

Rathi et al. [21] investigated the intra- and inter-rater reliability of a therapist with minimal training and an ultrasonographer in quantifying anterior and posterior glides of the Glenohumeral Joint (GHJ) of 12 healthy participants in two positions at rest. Both raters demonstrated good intra-rater reliability (PT ICC: 0.86 to 0.98, US ICC: 0.85 to 0.96). For posterior glide, the inter-rater reliability was moderate-good (ICC: 0.50 to 0.75) and poor-moderate for anterior glide (0.31 to 0.53). Staes et al. [22] tested the intra- and inter-rater reliability of two skilled therapists in assessing the available motion and end-feel of carpal joints in 30 healthy, unimpaired students and 15 patients with impairment on two separate occasions. In both groups, intra- and inter-rater reliability was demonstrated ranging from 67% to 97% with 60% to 100% agreement in the healthy and impaired groups, respectively.

The Mobil-Aider® device for measurement of linear translation

The Mobil-Aider® (Therapeutic Articulations, LLC, Spring City, PA) is a new FDA-cleared device (Figure 1). A proof-of-concept study by Gulick [23], which compared translation measurements of the knee (Lachman Test) obtained using the device to radiography, demonstrated a strong correlation. Additionally, reliability and concurrent validity was found between the Mobil-Aider® and the Zeiss Smartzoom Microscope. Pearson correlation coefficients for this laboratory research were near-perfect (0.986 to 0.997) [24]. A study by Tuzson and Tarleton (2021) compared the Mobil-Aider® to electromagnetic motion analysis. The study assessed posterior GHJ translation and reported a 0.83 correlation [25]. In another study, an experienced therapist but novice in the use of the Mobil-Aider®, demonstrated good and excellent intra-rater reliability using Grade IV posterior glides of the GHJ (ICC3, k=0.771) and volar glides of the Radiocarpal Joint (RCJ) (ICC3, k=0.904), in healthy, unimpaired participants [26]. To confirm previous findings, the aim of the present study was to assess the intra-rater reliability of the Mobil-Aider® in measuring linear translation during posterior glides of the GHJ and volar glides of the RCJ in healthy, unimpaired participants within two independent investigators. In addition, inter-rater reliability between two independent investigators in measuring linear translation using the Mobil-Aider® device is also reported.

Materials and Methods

Following informed consent, a normal and healthy sample of convenience was admitted consisting of doctor of physical therapy students. To ensure that the study was sufficiently powered, a sample size calculation was conducted. When the rater performed three repetitions of rating each mobilization, a minimum sample size of 11 participants were required to achieve the statistical significance of at least 80% (alpha-value set at 0.05). The number of subjects admitted into the study was 32, which exceeded the number needed to ensure sufficient power. Accessory glides were performed for a total of three trials on each joint during a single session by two physical therapists with 30 years and 37 years of experience for the purpose of assessing both intra-rater reliability of each investigator, as well as inter-rater reliability between investigators. Each investigator was blinded to the digital display on the Mobil-Aider® for all measures and were also blinded to the data from the other investigator. Trials were performed in a randomized fashion. A co-investigator palpated and marked the joint line prior to application of the device and recorded all measures from the device.

For the GHJ, participants were placed in supine with a mobilizing

Figure 1: Mobil-aider® device.

Figure 2: Glenohumeral posterior glide with the mobil-aider®.

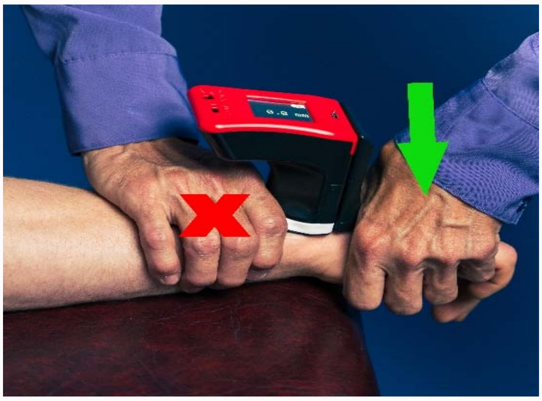

Figure 3: Radiocarpal volar glide with the mobil- aider®.

wedge stabilizing the scapula, posteriorly. The GHJ was positioned in the plane of the scapula. The investigator then aligned the stationary arm of the device over the clavicular region and the axis of the device with the GHJ line (Figure 2). Following several lower-grade trials to confirm alignment, the investigator performed a series of three Grade IV accessory glides with a 15 second rest between trials, moving the head of the humerus and mobile arm of the device in a posterolateral direction.

For the RCJ, participants were placed in sitting with the forearm in pronation and supported on a table with the distal forearm additionally supported on dense foam. The stationary arm of the device was stabilized on the distal radius. The investigator then aligned the device over the radiocarpal joint line (Figure 3). Following several lower grade trials to confirm alignment, the investigator performed a series of three Grade IV accessory glides with a 15 second rest between trials, moving the proximal row of carpal bones with the mobile arm of the device in a volar direction.

Results

There were 32 participants (16 males, 16 females) with a mean age of 24.81 years. A two-way mixed effects consistency model (ICC 3, k) for intra-rater and inter-rater reliability was used. Criteria for interpretation of ICC data were based on Cicchetti [27].

Posterior glide of the glenohumeral joint

For posterior glide of the GHJ for investigator 1, the means were closer for measure #2 and #3 then measure #1. This was confirmed by measurements #2 and #3 having a higher correlation with each other than either of them with measurement #1. For investigator 1, good intra-rater reliability was demonstrated with ICC(3,k) = 0.691, F(31,62) = 7.718, p=0.000 (Table 1).

For investigator 2, the means revealed that measure #3 was higher than measure #1 and #2. This was confirmed by correlations between ratings, where measures #1 and #2 had a higher correlation than that of measures #1 or #2 with measure #3. For investigator 2, excellent intra-rater reliability was demonstrated with ICC(3, k) = 0.789, F(31,62) = 12.227, p=0.000 (Table 2).

For posterior glide of the GHJ, inter-rater reliability between investigator 1 and 2 revealed an ICC(3, k) = 0.546, demonstrating fair agreement.

Volar glide of the radiocarpal joint

For volar glide of the RCJ for investigator 1, the means were very consistent, which was confirmed by correlations being very high and similar. Excellent intra-rater reliability was demonstrated with ICC(3,k) = 0.932, F(31,62) = 42.021, p=0.000 (Table 3).

For investigator 2, the means for measure #2 and #3 were closer to each other than to measure #1. This is confirmed by measures #2 and #3 being more closely correlated. Excellent intra-rater reliability was demonstrated with ICC(3,k) = 0.917, F(31,62) = 34.257, p=0.000 (Table 4).

For volar glide of the RCJ, inter-rater reliability between investigator 1 and 2 revealed an ICC(3,k) = 0.462, demonstrating fair agreement.

Discussion

Consistent with previously published data, results of the present study revealed that intra-rater reliability was excellent for assessment of volar glide of the RCJ and good to excellent for assessment of posterior glide of the GHJ using the Mobil-Aider® device. It is understandable that intra-rater reliability was better when assessing linear translation of the RCJ compared to the GHJ, since there is more soft tissue present at the shoulder, which makes assessment of end range motion more challenging. Inter-rater reliability is generally less favorable than intra-rater reliability, especially when assessing accessory joint mobility. Despite more favorable intra-rater reliability for assessment of volar glide of the RCJ for both investigators, inter-rater reliability for posterior glide of the GHJ revealed slightly more favorable results than inter-rater reliability for volar glide of the RCJ. This may be explained by the fact that there is less linear translation of the RCJ (3.9 mm to 5.6 mm *vs.* 10.77 mm to 13.0 mm) and thus,

Table 1: Investigator 1 glenohumeral posterior glide data.

GHJ	Mean	Standard Deviation	Correlation Matrix Investigator 1		
			Measure #1	Measure #2	Measure #3
Measure #1	12.69	1.91	1	0.692	0.682
Measure #2	13	1.61	0.692	1	0.726
Measure #3	12.91	1.6	0.682	0.726	1

Table 2: Investigator 2 glenohumeral posterior glide data.

GHJ	Mean	Standard Deviation	Correlation Matrix Correlation Matrix		
			Measure #1	Measure #2	Measure #3
Measure #1	10.77	2.18	1	0.814	0.77
Measure #2	11.15	2.41	0.814	1	0.789
Measure #3	11.29	2.22	0.77	0.789	1

Table 3: Investigator 1 radiocarpal volar glide data.

RCJ	Mean	Standard Deviation	Correlation Matrix Investigator 1		
			Measure #1	Measure #2	Measure #3
Measure #1	4.21	1.77	1	0.93	0.92
Measure #2	4.01	2	0.93	1	0.93
Measure #3	3.90	1.82	0.92	0.93	1

Table 4: Investigator 2 radiocarpal volar glide data.

RCJ	Mean	Standard Deviation	Correlation Matrix Investigator 1		
			Measure #1	Measure #2	Measure #3
Measure #1	4.9	1.49	1	0.89	0.9
Measure #2	5.1	1.47	0.89	1	0.95
Measure #3	5.36	1.55	0.9	0.95	1

any discrepancy between investigators represents a larger percentage of difference and, therefore, less agreement. Additionally, when a greater quantity of joint motion is available, the amount of force used between two investigators may affect inter-rater reliability but may not affect consistency within each investigator. The amount of translational force utilized may also be impacted by gender and size differences between investigators, a potential factor that may have influenced the results in the present study. Despite the ability of the Mobil-Aider® to measure translational forces, the device is interfaced between the user and the subject, which may impact the ability of the user to sense the end-feel of the motion. This limitation may be mitigated through additional practice with the device.

The present study confirms previous findings [23-25]. In combination with the previously published initial intra-rater reliability study, these results suggest good clinical utility for the use of the Mobil-Aider® for measurement of linear translation at the GHJ and RCJ. This is particularly true for assessment of accessory motion of the GHJ and RCJ by a single clinician and between clinicians when measuring accessory motion of the GHJ.

These results have implications for assessment of joint mobility in clinical practice by establishing the reliability of a device designed to quantify joint linear translation. This device may be useful during examination in providing objective data that can be used to identify mobility deficits and objectify changes in response to joint mobilization procedures. Further, these results may also provide important data used to guide the application of joint mobilization by serving to standardize the quantity of joint translation associated with a specific mobilization grade. This will improve the consistency with which joint mobilization is performed. The literature reveals that assessment of accessory motion in the spine and extremities lacks reliability and validity [28-30]. The present study extends previous assertions by demonstrating a moderate level of consistency when measuring linear translation of the GHJ, which holds promise for the use of the Mobil-Aider® in clinical practice.

The requirement for timely and precise feedback during instruction in psychomotor skills demands a method for ensuring consistency in the application of force. In combination with previously published results, the present study supports the use of the Mobil-Aider® as an adjunctive teaching instrument for instruction in joint mobilization procedures. Through use of this device, learners can more closely replicate the forces that are used by the instructor and be more consistent in their application of graded forces during skill acquisition. The Mobil-Aider® provides immediate and precise feedback in millimeters that can be easily viewed by the operator during performance of the task. The learner is able to perceive the translation of the joint manually while observing the precise quantity of linear translation that is being provided. This allows for adjustment of forces and consistency in force application during multiple trials by providing an intrinsic feedback loop where force application-assessment-re-application-re-assessment leads to refined development of these motor skills. In a similar way, applying the Peyton model of instruction in manual skills, the Mobil-Aider® has the potential to assist in the deconstruction and comprehension phases in order to fine-tune the performance phase by allowing improved reproduction of the amount of translational force applied by the learner in order to match that which is applied by the instructor. The self-explanation component involved with this method supports general learning theory in which memory retention is improved through the activity of teaching [31]. In addition, the Mobil-Aider® may be useful not only in skill training and acquisition but also in verifying correct performance of a joint mobilization technique during skill checks, practical examinations, or in the clinic. In this way, learner performance in the application of linear translation may be quantifiably assessed to ensure that appropriate forces are used to elicit the desired grade of mobilization.

Conclusion

When used by experienced physical therapists, the Mobil-Aider® device demonstrates moderate to good and excellent intra-rater reliability of Grade IV posterior glides of the GHJ and volar glides of the RCJ, respectively, in healthy, unimpaired participants. In addition, fair inter-rater reliability of Grade IV posterior glides of the GHJ and volar glides of the RCJ was demonstrated. Combined with previously published data, the clinical utility of this device in quantifying end range joint translation of the GHJ and RCJ during the performance of accessory motion testing and joint mobilization is supported. Further, the opportunity for the Mobil-Aider® to provide real-time, precise data related to linear translation supports its use during instruction of joint mobilization and manipulation procedures.

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