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Research Article

COMPARISON OF PALMAR ABDUCTION IN THREE WRIST POSITIONS AMONG HEALTHY ADULTS USING CONVENTIONAL GONIOMETER

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A B S T R A C T

Introduction: Measurement of palmar abduction at carpometacarpal joint (CMCJ) of thumb is routinely performed in various conditions of hand dysfunction. Different techniques and tools are employed to measure CMCJ range of motion (ROM). Although, measurement techniques are largely similar, the approach adopted for position of wrist varies. Present study explores association of wrist position with palmar abduction of CMCJ and provides discussion pertaining to method of range of motion measurement. **Purpose:** Present study intends to explore the association of wrist position and palmar abduction of CMCJ in healthy adults to recommend a biomechanically sound technique for range of motion measurement. **Methods:** Active and passive palmar abduction range of motion was measured on both hands of 300 healthy adults with wrist positioned in flexion, extension, and neutral. Data were analyzed to obtain statistical significance of the measured differences. **Results**: Significant difference was noted ($p < 0.05$) in average palmar abduction with wrist in neutral (51.6°), flexion (47.8°) and extension (56.8°) positions in all age groups. Comparison of dominant hand and non-dominant hand range of palmar abduction revealed significant difference ($p < 0.05$) between dominant hand and non-dominant hand. Males demonstrated greater range of palmar abduction than females ($p < 0.05$). **Conclusion**: The position of wrist has significant influence on range of motion of palmar abduction. Therefore, while using standard goniometer for measurement of CMCJ, it is recommended that therapist should maintain same wrist position during each follow-up measurement. Alternatively, a tool which holds wrist in same position consistently during CMCJ ROM measurement may be used for more reliable measurement.

INTRODUCTION

The human hand has a much larger, mobile and fully opposable thumb which enables fine motor skills and precision. [1]Mobility of human thumb is a critical component of hand's ability to grasp and manipulate objects. [4][14] Therefore it is important to measure thumb range of motion to provide information for precise description of thumb function in daily life activities. [5]

According to clinical assessment recommendations, measurement of palmar abduction of thumb should be performed in neutral wrist position[6] However, there is paucity of literature supporting significance of wrist position during measurement of thumb palmar abduction. There is paucity of clarity in existing literatures about optimal wrist posture during measurement, ranging from extreme extension to full flexion. Present study intends to explore the impact of wrist posture on palmar abduction of thumb. We also intend to discuss the clinical significance of our findings and inform about the best wrist position for measurement of thumb palmar abduction.

The literature search indicates that wrist position during measurement of the thumb palmar abduction is primarily to accommodate the instrument's design. In contrary, we believe, instrument design should accommodate the ideal position of wrist during measurement. The design of pollexograph and torque-controlled device makes it necessary for wrist to be in neutral. [2][3] On other hand goniometer, distance-measurement method, vicon camera system, hand photogrammetry, 4 dimensional CT, electromagnetic device and video technique tools do not specifically emphasize on wrist joint position.[8][9][10] This observation forms the construct of our study's research question "Does various wrist position make significant difference on thumb palmar abduction?". If yes, which wrist position yields more consistent measurement. In this study, we hypothesize that wrist position impacts measurement of thumb palmar abduction and neutral wrist position produces the most consistent measurement. To test hypotheses, we collected data and performed statistical comparison. Implications of study stipulate discussion on measurement technique of thumb palmar abduction and improvisation of involved instrument's design. Also, palmar

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abduction is restricted in pathological conditions such as 1st CMC joint osteoarthritis, rheumatoid arthritis, dequervain tenosynovitis, distal end radius fracture, dislocation of thumb and burns. Preoperatively, normative values of palmar abduction will be useful for clinicians to quantify baseline objective measure of range of palmar abduction. Postoperatively, an individualized treatment program can be designed to train patients in specific wrist position to minimize the incidence of joint restriction. Therefore, present study intends to explore influence of wrist position on range of motion of palmar abduction to recommend ideal wrist posture for measurement of palmar abduction.

MATERIALS AND METHODS

Study commenced after approval of research proposal by Institutional Ethics Review Committee, MGM Institute of Health Sciences, Kamothe, Navi Mumbai. It was an exploratory cross-sectional study conducted at MGM School of Physiotherapy, Navi Mumbai. Sample size was calculated based on our study findings, considering mean 51.65, Standard deviation 6.52, power of 80% and alpha equal to 0.05. Estimated sample size was 254.According to Erickson classification three-hundred participants between the age-group of 18-75yrsfrom each group of young adulthood (63 females and 37males), middle adulthood (50females and 50 males) and late adulthood (64females and 36males) were recruited from Mumbai and Navi Mumbai through convenient sampling technique. Participants were explained the purpose of study and written consent was sought from all participants. Participants who have suffered any recent neuro-musculoskeletal injury (<3 months), history of fracture and dislocation of thumb, burns, past history of hand surgery, rheumatoid arthritis, de- Quervain's tenosynovitis, nerve palsy, distal end radius fracture, hypo-plastic thumb were excluded from the study.

Demographic data were collected including hand dominance and occupation. Anthropometric data were recorded including hand length, hand breadth, hand span, wrist circumference and forearm girth. Manual 180° six inch plastic conventional finger goniometer was used to measure palmar abduction with wrist in three positions flexion, extension and neutral. [6]Active and passive range of motion was measured on both hands of all 300 healthy adults. Prior to commencement of data collection, a practice trial was given to all participants to familiarize with goniometer and measurement technique including required posture of elbow, forearm, and wrist and hand position.

Three trials were performed in each position. Mean of 3 trials were recorded as final range of motion. Active and passive thumb range of motion was measured with participant seated and elbow flexed at 90 degree. [6][13][15]For consistency, passive range of motion was measured by applying 100gram of force with spring scale. Total time to perform all measurements was approximately 10 minutes per participant. Retest was performed half an hour after the test to minimize effect of fatigue. Intraclass correlation coefficient of 0.99 revealed conventional finger goniometer provided reliable and reproducible data in evaluation of palmar abduction. Based on our results of reliability study, it was concluded that conventional finger goniometer was a reliable tool for evaluating palmar abduction. Hence, conventional finger goniometer was used in present study.

RESULTS

Three-hundred participants between the age-group of 18-75yrs from each group of young adulthood (63 females and 37males), middle adulthood (50females and 50 males) and late adulthood (64females and 36males) were included in the study.

Table 1 Demographic characteristics

Demographic characteristics	Male Participants (n=122) Mean(SD)	Female Participants(n=178) Mean(SD)
Age (yr)	45.47(18.2)	44.74(19.9)
Body Weight (kg)	67.86(13.6)	60.67(10.6)
Height (m)	1.65(0.08)	1.57(0.06)
BMI (kg/m^2)	24.43(4.06)	24.58(4.04)

*Significant at $p \leq 0.05$

Table 2 Palmar abduction in three wrist positions

Palmar abduction	Wrist position	Mean (SD)	p-value
		Dominant	
Active motion	Neutral	51.6 (6.5)	
	Flexed	47.8 (5.1)	**0.000***
	Extended	56.8 (5.1)	
	Neutral	53.7 (6.6)	
Passive motion	Flexed	49.8 (5.3)	**0.000***
	Extended	58.7 (5.3)	
		Non- dominant	
Active motion	Neutral	50.1 (6.4)	
	Flexed	46.6 (5.0)	**0.000***
	Extended	54.9 (4.9)	
	Neutral	52.0 (6.6)	
Passive motion	Flexed	48.5 (5.2)	**0.000***
	Extended	56.9 (4.8)	

*Significant at $p \leq 0.05$

Table 3 Comparison of active and passive range of palmar abduction with three wrist positions

Wrist Positions	Palmar Abduction Mean (SD)					
	Dominant			Non-dominant		
	Active	Passive	p value	Active	Passive	p value
Neutral	51.6 (6.5)	53.7 (6.6)	**.000***	50.1 (6.4)	52.0 (6.6)	**.000***
Flexed	47.8 (5.1)	49.8 (5.3)	**.000***	46.6 (5.0)	48.5 (5.2)	**.000***
Extended	56.8 (5.1)	58.7 (5.3)	**.000***	54.9 (4.9)	56.9 (4.8)	**.000***

*Significant at $p \leq 0.05$

Analysis was carried out using statistical tool IBM SPSS (2015) version16. Statistical significance was set at $p \leq 0.05$. Friedman ANOVA test comparing palmar abduction range with wrist in full flexion, neutral and full extension revealed significant difference ($p \leq 0.005$). Also it was noted that range of palmar abduction was lowest with wrist in full flexion and highest with wrist in full extension.

Comparison of dominant side and non-dominant side range of palmar abduction using Wilcoxson signed rank test revealed that there is a significant difference ($p < 0.05$) between dominant side and non-dominant side range with dominant side being consistently greater than non-dominant side.

Table 4 Comparison of palmar abduction with dominant and non-dominant hand

Wrist Positions	Palmar Abduction Mean (SD)					
	Active			Passive		
	Dominant	Non-dominant	p value	Dominant	Non-dominant	p value
Neutral	51.6(6.5)	50.1(6.4)	**0.000***	53.7(6.6)	52.0(6.6)	**0.000***
Flexed	47.8(5.1)	46.6(5.0)	**0.000***	49.8(5.3)	48.5(5.2)	**0.000***
Extended	56.8(5.1)	54.9(4.9)	**0.000***	58.7(5.3)	56.9(4.8)	**0.000***

*Significant at $p \leq 0.05$

Table 5 Comparison of palmar abduction with males and females

Wrist Positions	Palmar Abduction Mean (SD)											
	Active						Passive					
Neutral	Dominant			Non-dominant			Dominant			Non-dominant		
	Males	Females	p value	Males	Females	p value	Males	Females	p value	Males	Females	p value
	54.7(6.5)	49.4(5.6)	**0.000***	53.1(6.4)	48.1(5.6)	**0.000***	56.7(6.6)	51.6(5.7)	**0.000***	55.1(6.4)	50.0(5.9)	0.000*
Flexed	50.2(5.0)	46.3(4.5)	**0.000***	48.9(5.1)	45.0(4.4)	**0.000***	52.0(5.1)	48.3(4.8)	**0.000***	50.6(5.2)	47.0(4.7)	0.000*
Extended	59.3(5.0)	55.1(4.5)	**0.000***	56.8(4.9)	53.6(4.4)	**0.000***	61.1(5.3)	57.1(4.7)	**0.000***	58.7(4.8)	55.7(4.4)	0.000*

*Significant at $p \leq 0.05$

Wilcoxson signed rank test revealed significant difference ($p < 0.05$) between active and passive range of palmar abduction with passive range been greater than active range. (Table 3 and 4).

Mann Whitney test was performed to compare palmar abduction between male and female groups. Test result revealed significant difference with males having greater range of palmar abduction than females in all three groups. A weak negative correlation was observed between age and palmar abduction range on Spearman correlation test.(Table 5)

DISCUSSION

Results of present study supports hypothesis that wrist position impacts measurement of thumb palmar abduction. Palmar abduction range was highest in wrist extension and lowest in wrist flexion. Same wrist position must be ensured to obtain reliable measurement on test and re-tests. The most commonly used goniometer does not have additional arms to stabilize wrist in a particular position during measurement. However, clinicians can ensure consistent wrist position using external block for wrist movement during measurement. Pollexograph was devised to measure thumb palmar abduction while blocking wrist movement because it is reliable than goniometer, reflecting the importance of wrist positioning in measurement of palmar abduction and supports the findings of this study. [6][12][15] However, further study is required to establish the optimal wrist position for measurement of thumb palmar abduction. Hence, study opens up scope of product development to substitute the standard goniometer for measuring thumb palmar abduction.

Present study consistently finds range of motion of palmar abduction on dominant side greater than that of non-dominant side. Clinicians usually consider contralateral joint as reference. [11]Our finding suggests that a correlation with functional needs of the patient should be performed to determine target range. Greater range of motion of palmar abduction was noted in male participants. However, we did not perform anthropometric and occupational correlation to determine the exact attributing factors for this difference. Weak negative co-relation was seen between age and active and passive palmar abduction.

Clinical implication

Reference values generated from normative data obtained from healthy Indian adults will be helpful to researchers and clinicians in determining level of performance in patients with hand dysfunction. This will help clinicians, orthopaedicians and hand surgeons to evaluate and monitor treatment outcomes in surgical and non-surgical conditions such as rheumatoid hand, stiff hand, compartment syndromes and post-operative outcomes of reconstructive surgeries. Normative values will aid orthotists in designing appropriate splints. In the field of academics, knowledge of different wrist positions will be helpful in training students to understand influence of wrist position on palmar abduction.

Future recommendations

Further study is required to establish the optimal wrist position for the measurement of thumb palmar abduction.

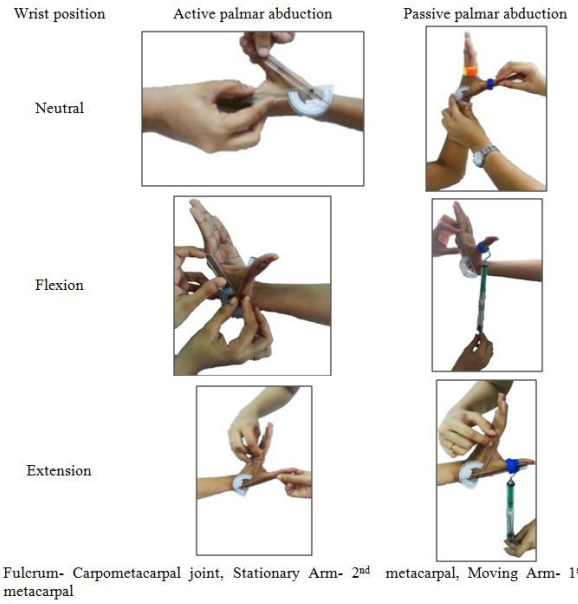

Figure 1 Measurement of palmar abduction in three wrist positions

CONCLUSION

Palmar abduction motion varies with wrist position. Range of palmar abduction was maximum in wrist extension, followed

by wrist in neutral and least in wrist flexion position. It is recommended that same wrist position is maintained during repeated measurement of carpo-metacarpal joint motion with conventional goniometer.

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