



Research Article

Effect of Palmaris Longus on Handwriting Skills

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ABSTRACT

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Background: Kinesiologists, Physical Anthropologists, and Anatomists have all long been captivated by the structure and development of the superficial forearm flexor, the Palmaris longus.

Objective: To study the effect of Palmaris Longus on certain handwriting skills.

Subjects and Methods: Three Palmaris Longus occurrence tests were conducted on 200 students (100 males and 100 females) affiliated to Colleges of Medicine of Baghdad University then the participants were tested for certain handwriting skills to correlate the presence of Palmaris Longus in the dominant side with handwriting.

Results: 89% of all subjects (178 subjects) and 91% of males were right-handed. Dominant Palmaris Longus among males (61%) was significantly higher than that of females (30%). Regarding the Motor assessment scale; female participants achieved good and it was significantly higher than that of males (23%). There was a significant association between left Palmaris Longus only and acceptable horizontal line assessment. Good sentence composition was noticed significantly in dominant Palmaris Longus.

Conclusions: Variation of presence of Palmaris Longus in both sexes in the studied group meets with normal recorded variation. Presence of Palmaris Longus in the dominant forearm has correlation with good certain skills of handwriting skills.

Introduction

Our hand is a remarkable tool that benefits us greatly in a wide variety of aspects. Handwriting is at the top of the so-called "endangered" human traditional activities list, as it is very likely to become extinct shortly since it is being replaced by advanced technologies with smartphones and computers. The majority of everyday tasks are carried out using both hands, with the dominant hand serving as the principal coordinator and the hand that is not dominant acting as the seconder. (1). Rapidity and readability are important factors while writing One's capacity to completely convey

their expertise and abilities through text words can be negatively impacted by inadequate writing skills, which can also negatively affect one's contentment, innovation, and efficiency. The Palmaris Longus Muscle (PL) is believed to be the greatest altering structure in our bodies. In addition to lack of it, there are differences in origin, insertion, and form. (2). It has been proposed that the alleles for its dual missing may be described as recessive dominant for the alleles for its occurrence. (3). About 22.4% of Caucasians can have single or dual PL absences, within an estimate of 30%-63.9%, depending on

the ethnicity; its agenesis is reported in 63%, 30.7% and 50.8% in the population of Turkey, Iran and Egypt (4). Anatomically, PL is a delicate, slim, mandrel shaped muscle that assists in wrist flexion and it is located medial to the flexor carpi radialis (figure 1). The sum and shape of PL muscles might vary greatly. It receives arterial blood source by a minor stem of the anterior ulnar recurrent artery, and innervated by multiple branches of the median nerve, each containing C5-T1 fibers (5). It may be vanished, binary, fissured, resembling a tendon, two-bellied and could take several sites as insertion. These involve flexor retinaculum, the deep fascia of; the forearm and hypothenars, abductor pollicis brevis, the metacarpophalangeal joints, the flexor carpi ulnaris tendon, pisiform or scaphoid (6). Surgeons concur that PL is the greatest option for tendon grafting in another tendon rebuilding, aiding the activity of paralytic muscles employed for treating paralyses of the face, poses, and urine incontinence (7). Long held beliefs included that the PL's total contribution to hand function is negligible. The performance of the PL had been found to be significantly higher in those who participated in sustained grip sports, like tennis and badminton, when compared to intermittent grip sports like rowing, hockey and cricket (8). Previous authors concluded that PL presence or absence was not significant regarding the hand strength; handgrip and pinch strength (9). Nonetheless, it had been proved that the PL increased pinch strength in the ring and little fingers of the dominant hand strengthening digits opposition (10). On the contrary, the risk of Dupuytren's disease (11), carpal tunnel syndrome (12), and median nerve compression (13) significantly increased when the PL was prevalent.

This study aims to reveal the association between PL and hand-writing skills.



Figure1: Palmaris longus muscle

Subjects and Methods

A total of 200 students participated in this cross-sectional study, a hundred of males and females equally, affiliated to Colleges of Medicine at Baghdad University from January to June of 2023. The participants were selected in stratified random fashion when their ages ranged from 18 to 23 years. This work was conducted after gaining the approval from the college's scientific committee. A written consent was distributed and explained verbally to all students regarding the research idea including the clinical examinations and writing tests. Any subjects had upper limb injury ($\neq 5$) or refuse to participate for any reason, the subject was excluded from the study.

Three tests were carried out to settle the presence of PL whether it is in one arm, or both, or not visible, the subject is asked to: approximate the distal phalanx of the thumb to that of little finger after that to flex the wrist; "Schaeffer's Test" (14). Then the participant is asked to fully extend the interphalangeal joints of the index and middle fingers then to flex the wrist and other fingers, and finally the thumb is fully opposed and flexed; "Pushpakumar's Test" (15). After that, the examiner passively hyper-extends all the metacarpophalangeal joints followed by active flexion of the wrist joint; "Mishra's Test" (14). If any of the tests revealed PL, the subject is considered to have the muscle in right, left or both fore arms.

A valid and reliable measurement tool was employed to establish and measure handwriting performance. A manual, had been developed and used at the University of Western Sydney by clinicians in adult neurological rehabilitation, was used in this work (16). It evolved to improve the accuracy with which physicians administered and scored tests. It provides therapists with quantifiable outcomes. The battery of tests is brief, easily applicable, confined by specific time, and accentuates the handwriting's motor elements; Motor assessment scale of pen control and manipulation:

Horizontal line drawings: the subject is taught to sketch a minimum of 10 horizontal lines to halt at a perpendicular limit line thru 20 seconds. This task is achieved only when they have at least five horizontal lines touching the vertical limit lines on both sides of the page and not exceeding either of the lines $>2\text{mm}$ (figure 2).

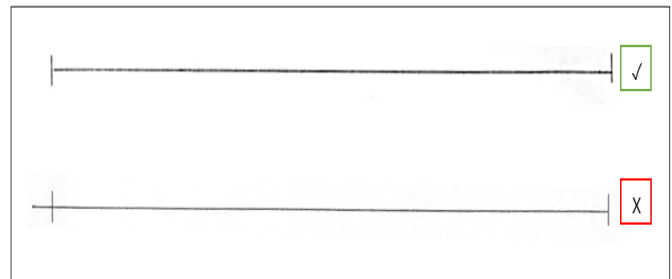


Figure 2: Examples of Acceptable (above) and not acceptable (below) Horizontal Lines

Dots writing: On a piece of paper, the participant is told to draw quick, successive points. It is completed only by writing down at least 10 dots on the page in 20 seconds, at least 2 dots a second for 5 seconds (figure 3).

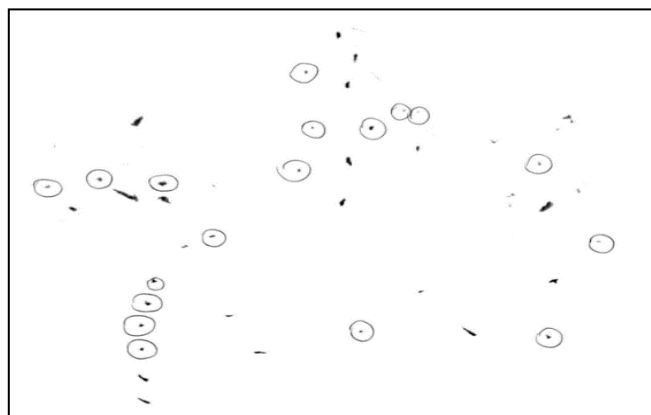


Figure 3: Examples of Acceptable dots are circled, anything not circled is Unacceptable.

Numeral writing: In this task the subject is asked to write the numbers 1-12 with only one mistake allowed to achieve the task with time recorded in seconds. Numerals are illegible when: it is not easily and quickly recognized out of context at first glance, written numbers are poorly formed, distorted, reversed, or greatly rotated, if a number has extraneous parts with dark writings, presence erasures, parts are omitted, improperly closed or crossed, if numerals are joined, share a part, or overlap to form individual numbers, if the numeral is confused with another letter or numeral, or finally, if the whole numeral is absent or out-of-place in sequence. The score would be according to the equation of:

$$\text{Total Numeral Legibility \%} = \frac{12 - \text{total of illegible numbers}}{12}$$

Sentence composition: A minimum of five words must be used in the participant's phrase, which must be written in three seconds, and again, with only one mistake allowed to achieve the task. The formula of word legibility percentage =

$$\frac{\text{correct words (or letters)}}{\text{total words (or letters)}} \times 100$$

Version 26 of the Statistical Package for Social Sciences (SPSS) was employed for the analysis of statistics. The information is displayed as means, standard deviations, and ranges. Categorical data presented by frequencies and percentages. Pie chart was used, and a level of p-value less than 0.05 was considered significant.

Results

The results of this study showed that 89% (178) of the participants (100 males & 100 females) were right-handed. Table 1 illustrates that 91% of male students were right-handed, which was not significantly differ than the rate of right-handedness among female (88%), p-value =0.479. Table 1 illustrates that 91% of male students were right-handed, which was not significantly differ than the rate of right-handedness among female (88%), p-value =0.479.

Table 1: association between gender and handedness

| Gender | | Handedness | | | | p value |
|--------|----|------------|---------|-------|---------|---------|
| | | Right | | Left | | |
| | | Count | Row N % | Count | Row N % | |
| Male | 91 | 91.0% | 9 | 9.0% | 0.479 | |
| Female | 88 | 88.0% | 12 | 12.0% | | |

PL laterality distribution among the participants is illustrated in figure (4).

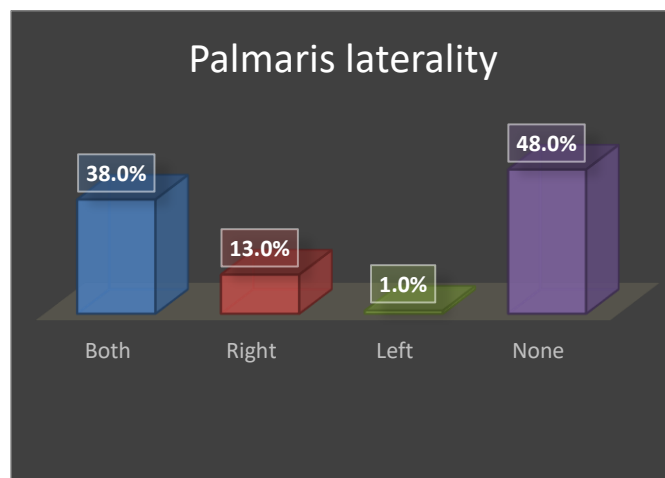


Figure 4: distribution of studied subjects according PL laterality

Table 2 demonstrates the rate of absent PL, it was significantly higher among females (65%) than that among males (31%) with p-value = 0.001.

| | Gender | Palmaris laterality | | | | | | | | p value |
|--------|--------|---------------------|----|-------|---|------|----|-------|--------|---------|
| | | Both | | Right | | Left | | None | | |
| | | N | % | N | % | N | % | N | % | |
| Male | 52 | 52.0% | 15 | 15.0% | 2 | 2.0% | 31 | 31.0% | 0.001☆ | |
| Female | 24 | 24.0% | 11 | 11.0% | 0 | 0.0% | 65 | 65.0% | | |

Table 3 shows that the rate of dominant PL among males (61%) was significantly higher than that of females (30%) p value = 0.001.

Table 3: Association between gender and presence of dominant PL

| Gender | | Presence of dominant PL | | | | | | p value |
|--------|--|-------------------------|---------|--|--------------|---------|--------|---------|
| | | Dominant | | | Not dominant | | | |
| | | Count | Row N % | | Count | Row N % | | |
| Male | | 61 | 61.0% | | 39 | 39.0% | 0.001☆ | |
| Female | | 30 | 30.0% | | 70 | 70.0% | | |

Table 4 displays the rate of students who achieved motor assessment scale dot, 39% of the female participants achieved good and it is significantly higher than that of males (23%) with p-value= 0.014. The table also illustrates that in horizontal line assessment, there was a significant association between left PL only and acceptable horizontal line assessment with p-value= 0.014. In addition, a significant association between the presence of PL on the subject's dominant side and horizontal line assessment with a p-value of 0.022.

As shown in table 5, there is a significant association between Left PL laterality and good writing assessment p-value= 0.032. Also, there is a significant association between dominance of PL and good numeral writing assessment with a p-value= 0.003. Moreover, a significant association was found between good sentence composition and presence of dominant PL p-value= 0.016.

Table 4: Association between motor assessments of scale-dot and horizontal line, with gender, handedness, PL laterality and dominant PL.

| | | Scale-dot assessment | | | | p value | Horizontal line assessment | | | | p value |
|---------------------|--------------|----------------------|-------|--------------|-------|---------|----------------------------|--------------|-----|-------|---------|
| | | Good | | Not achieved | | | Acceptable | Unacceptable | | | |
| | | N | % | N | % | | | N | % | N | |
| Gender | Male | 23 | 23.0% | 77 | 77.0% | 0.014☆ | 34 | 34.0% | 66 | 66.0% | 0.463 |
| | Female | 39 | 39.0% | 61 | 61.0% | | 39 | 39.0% | 61 | 61.0% | |
| Handedness | Right | 56 | 31.3% | 123 | 68.7% | 0.799 | 66 | 36.9% | 113 | 63.1% | 0.750 |
| | Left | 6 | 28.6% | 15 | 71.4% | | 7 | 33.3% | 14 | 66.7% | |
| | Both | 28 | 36.8% | 48 | 63.2% | | 36 | 47.4% | 40 | 52.6% | |
| Palmaris laterality | Right | 7 | 26.9% | 19 | 73.1% | 0.486 | 8 | 30.8% | 18 | 69.2% | 0.014☆ |
| | Left | 1 | 50.0% | 1 | 50.0% | | 2 | 100.0% | 0 | 0.0% | |
| | None | 26 | 27.1% | 70 | 72.9% | | 27 | 28.1% | 69 | 71.9% | |
| Palmaris presence | Dominant | 32 | 35.2% | 59 | 64.8% | 0.245 | 41 | 45.1% | 50 | 54.9% | 0.022☆ |
| | Non-dominant | 30 | 27.5% | 79 | 72.5% | | 32 | 29.4% | 77 | 70.6% | |

Table 5: Association among Numeral writing assessment, Sentence composition assessment and gender, handedness, PL laterality and dominant PL.

| | | Numeral writing assessment | | | | p value | Sentence composition assessment | | | | p value |
|---------------------|---------|----------------------------|--------|------|-------|---------|---------------------------------|-------|-----|-------|---------|
| | | Good | | Poor | | | Good | Poor | | | |
| | | N | % | N | % | | | N | % | N | |
| Gender | Male | 34 | 34.0% | 66 | 66.0% | 0.061 | 30 | 30.0% | 70 | 70.0% | 0.232 |
| | Female | 47 | 47.0% | 53 | 53.0% | | 38 | 38.0% | 62 | 62.0% | |
| Handedness | Right | 72 | 40.2% | 107 | 59.8% | 0.816 | 64 | 35.8% | 115 | 64.2% | 0.126 |
| | Left | 9 | 42.9% | 12 | 57.1% | | 4 | 19.0% | 17 | 81.0% | |
| | Both | 37 | 48.7% | 39 | 51.3% | | 34 | 44.7% | 42 | 55.3% | |
| Palmaris laterality | Right | 12 | 46.2% | 14 | 53.8% | 0.032☆ | 9 | 34.6% | 17 | 65.4% | 0.055 |
| | Left | 2 | 100.0% | 0 | 0.0% | | 1 | 50.0% | 1 | 50.0% | |
| | None | 30 | 31.3% | 66 | 68.8% | | 24 | 25.0% | 72 | 75.0% | |
| Palmaris presence | Present | 47 | 51.6% | 44 | 48.4% | 0.003☆ | 39 | 42.9% | 52 | 57.1% | 0.016☆ |
| | Absent | 34 | 31.2% | 75 | 68.8% | | 29 | 26.6% | 80 | 73.4% | |

Discussion

Most of people are right-handed, whereas the percentage of left-handed people in the entire population is between ≈12%. Our results coincide with previous studies regarding the subject of majority of right-handed people and similarity in this criterion distribution in both genders (17). The desire for a dominant hand is a significant and could be exclusive characteristic of our species. Significant prejudices towards left-handed people exist in our culture and religion. Indeed, the word “sinister” linguistically indicates “harmful” or “evil.” For the variety of the dominant hand to persist, evolutionary forces have to exist (18). Although it might be learned, the hereditary effect (X linked) is remarkably constant (19). Left-handers were more likely to have accidents since the majority of tools were made primarily for right-handers, which led to negative selection.

In our study, the distribution of studied subjects according PL laterality was similar to recent studies (8,20,21,22), and it indicated a more significant absence of left PL. According to certain theories, this muscle is fast vanishing in mankind. Although the genetic bases of transmission are unclear, its absence seems to run in generations (23). It appears that laterality and gender beside its length, thickness and the race are points to consider for any surgeon intend to use PL tendon as a graft.

The rate of dominant PL among males (61%) was significantly higher in our study and this was in accordance with previous works, this may be attributed to lower levels of PL gene expressivity in females (24).

Concerning to the motor assessments of the hand writing skill, we found that there were significant associations between the presence of PL in dominant side and good results of each of the following assessment: horizontal line, numeral writing and sentence composition. As far as the abundance of literature, this is the first study that linked handwriting with PL presence. Although, it had been reported that PL has no effect on handgrip and pinch strength (20). Cetin et al. reported that PL significantly increases the pinch strength in the little and ring fingers of the dominant hand, but not for the index finger (8). We suggest that, it has an effect on fatigue resistance since PL presence had been found to be significantly higher in those who participated in sustained grip sports by stabilizing the wrist in a specific position and proving of greater proprioception (19).

Studies confirm that females tend to have better handwriting than males in terms of time, letter formation and quality factors and explained it as it is more common for females to have higher 2D:4D ratio, with the index finger being longer than the ring finger and the opposite being true for males. This happens early from elevated estrogen exposure that occurs first in prenatal period, also causing better and early maturity of neurodevelopment (24,25). All these explanations despite the high tendency of absent PL, could justify this study’s result regarding significant higher number of female participants who did achieve motor assessment scale dot than males. The obstacles that were faced in the current study was the difficulty to analyze multiple variables and the lack of researches of the current objectives. This could be conquered by artificial intelligence (AI) which is a valuable tool that can be used to utilize, gather, handle, and evaluate massive amounts of data (26).

Conclusion

The study group’s variance in the presence of Palmaris Longus in both sexes corresponds with the standard observed variation. From the current results, it can be assumed that females are more prone to lack a PL, males, on the other hand, are more likely to have PL on their dominant side. Markedly, having a dominant PL is associated with better some handwriting skills. Unfortunately, a better set of tests if conducted on a greater sample could reflect the association well.

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Conflict of Interest

Authors declare no conflict of interest.

Data availability

Data are available upon reasonable request.

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