Clinical and Ultrasonic Evaluation of the Thumb: Comparison of Young Adults With and Without Thumb Pain With Text Messaging

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Abstract

Objective: The aim of this study was to compare clinical and ultrasound findings of thumb joints in young adults with and without thumb pain associated with text messaging.

Methods: In this case-control study, 117 students with thumb pain associated with text messaging were evaluated clinically and with ultrasound analysis of the thumb. Age- and sex-matched controls received ultrasound evaluation to note any subclinical changes.

Results: Clinical examination in the cases identified tenderness most commonly in the metacarpophalangeal joints, followed by the carpometacarpal joints, and then the interphalangeal joints. Tenderness was noted in the web space and the anatomic snuff box. Hypermobility on the Beighton scale was recorded as 2. Grind tests were positive in 21% of participants. Grip strength did not differ, but lateral and tip pinch strength were significantly reduced in the cases compared with controls. Fluid was detected in the metacarpal joints by ultrasound but not in the carpometacarpal or interphalangeal joints. No changes were detected in the controls.

Conclusion: Clinical examination indicated involvement of all joints of the thumb, but ultrasound evaluation could identify changes only in metacarpal joints, indicating signs of possible subclinical changes taking place in the thumb in these participants as a result of repetitive use. (J Manipulative Physiol Ther 2018;41:199-207)

Key Indexing Terms: *Thumb; Metacarpophalangeal Joint; Carpometacarpal Joints*

Introduction

The increasing use of text messaging on mobile phones has focused concern on possible musculoskeletal disorders for the mobile phone users. The human body is well adapted to repetitive movement, and the upper limbs, although often considered vulnerable in this regard, are no different. This only becomes a potential problem when the repetitive action is continued for overly extended periods, or where substantial force is applied, or where the activity is carried out with parts of the upper limb in awkward postures. The operation of mobile phone keys is often and usually carried out using just the thumbs of each hand, but these are not as well designed for fine manipulative or dexterous work as are the fingers.[1] With repetitive movement as in text messaging on the mobile phones, both soft tissues and joints can be damaged.[2,3] It has been reported that high force at the joints is linked with increased flexion at the interphalangeal (IP) and metacarpophalangeal (MCP) joints.[4] Only 1 study has reported involvement in arthritis or subluxation with excessive use of mobile phone for texting.[5] These problems of thumb have been recognized by several physiotherapy associations around the world and by mobile phone operators.[6-8]

Thumb pain has also been reported in manual physical therapists and hand therapists as a result of the pressure applied during various techniques during treatment.[9-13] Repetitive movement of the thumb in text messaging can cause thumb pain and cases of thumb pain have been reported,[14-23] but no scientific study has been done to evaluate the joint involvement in participants with thumb pain because of excessive text messaging. The aim of the

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present study was to evaluate and compare the joints of the thumb in young adults with and without thumb pain with text messaging.

Methods

Ethics

The case-controlled study was approved by the Institutional Research Committee and the Institutional Ethical Committee of KMC Mangalore, Manipal University, Mangalore, Karnataka, India.

Participants

Students in the age group 18 to 29 years of both sexes using a cell phone were included for a survey to identify those students with symptoms in the upper limb with text messaging on the mobile phones.[24] Those who complained of pain in the thumb because of texting were selected for further evaluation of the thumb.

Students who had recent injury (<6 months) to the hand or upper limbs and those experiencing any inflammatory, degenerative, or neuromuscular conditions of upper limbs affecting the usage of limb for activities of daily living were excluded from the survey. Among the students who had thumb pain and were selected as cases, exclusion criteria were established by a personal interview with these students to exclude other causes of thumb pain such as recreational activities involving hand and computer keyboard usage.

Age- and sex-matched controls were selected from the students who were regular users of mobile phones but with no complaint of thumb pain. Participants gave informed consent for the evaluation themselves.

Instrument

A structured questionnaire was specially devised for the study. It included general questions that covered demographic information, the mobile phones used, and the duration of use. Questions were devised to identify the purpose for which the students used the phone frequently—for example, messaging, playing games, surfing the internet—because this could have implications regarding the causative factor. Information was collected regarding thumb pain (site of pain, severity of pain, type of pain, and duration of pain) with mobile phone use.

Procedure

The questionnaire was given to 1500 students to find the prevalence of thumb pain. Sample size was calculated using the formula $4pq/L^2$, where p = 21 (prevalence of symptoms from the pilot study), q = 79 (100 – 21), and L = 10% of p (90% power of the study). According to this formula, the sample size was calculated as 1504, which was rounded off to 1500. Of these, 1363 questionnaires were returned. There were 133 students (10%) who reported pain in the thumb that they attributed to excessive mobile phone use. None of the students reported excessive writing, which could have also caused pain. These students were then included, based on the inclusion and exclusion criteria, for clinical and ultrasound evaluation to document the clinical findings and possible clinical or subclinical changes in the thumb. The controls underwent ultrasound evaluation to detect any subclinical changes with excessive use of mobile phone because there were no clinical signs present. No clinical examination was done for the control group.

The cases and the controls were selected from the survey of 1500 students. After the initial survey all the students who complained of thumb pain were contacted and asked to participate in the study for clinical and ultrasound evaluation. A total 117 students consented. An equal number of students who used the mobile phones but did not complain of thumb pain were contacted to participate as controls. Of these 107 students underwent ultrasound evaluation; the other 10 refused ultrasound evaluation.

Measurements

Clinical. The physical examination included inspection for any change in color or localized swelling. We checked for tenderness at the joints of the thumb[25] and recorded active and passive movements of thumb. The Beighton 9-point scale for hypermobility measured the generalized ligament laxity. Special tests like the grind test were done to identify carpometacarpal (CMC) joint involvement.[25] Handgrip strength for both dominant and nondominant hands was measured with a JAMAR Adjustable Hand Dynamometer (Sammons Preston, Bolingbrook, Illinois) with the patient seated, shoulder adducted, and elbow flexed to 90° at position number 2 in the dynamometer.[26] A JAMAR Hydraulic Pinch Gauge (Sammons Preston) measured lateral and tip pinch bilaterally between thumb and index finger.[27] A Disabilities of the Arms, Shoulder, and Hand (DASH) questionnaire measured manual functions of the participants. Pain was recorded using the Numeric Pain Rating Scale (NPRS). The NPRS is an 11-point scale from 0 to 10 where 0 = no pain and 10 = the most intense pain imaginable. Students verbally selected a value most in line with the intensity of pain they have experienced. The NPRS has good sensitivity while producing data that can be statistically analyzed.[28]

Ultrasound Evaluation. Ultrasound evaluation was done for all the cases and the controls. A radiologist with special interest in musculoskeletal imaging carried out ultrasound evaluation by using a Voluson 730 Expert Series ultrasound machine (with 3-dimensional and 4-dimensional capabilities) with a high-frequency probe of 12 MHz for dedicated muscular skeletal imaging of the small joints of the thumb for any initial involvement of the joints.[29]

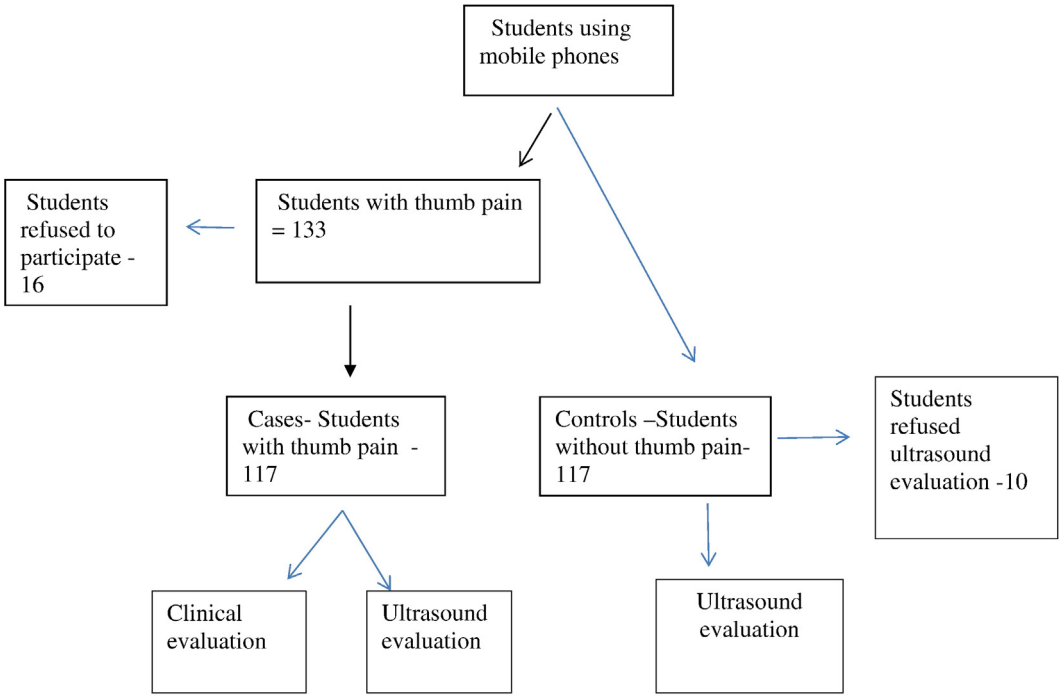

Fig 1. *Flow of participants through the study.*

Statistical Analysis

Statistical analysis was done using SPSS Software Version 11.5 (SPSS, Chicago, Illinois). The sample size of the survey study was calculated with 90% power as 1500 based on the formula 4pq/L2, where p = 21 (prevalence of symptoms from the pilot study), q = 79 (100 – 21), and L = 10% of p (90% power of the study). Of this, 1363 questionnaires were returned and among them 133 respondents complained of thumb pain. Because all 133 students who complained of thumb pain with excessive mobile use were taken for further evaluation, it represented 90% power based on the original calculation. Descriptive data of each variable were summarized as percentages of the respondents. Severity of pain (0-10 NPRS) was reported as median with interquartile ranges. Differences in cases and controls (thumb pain/no thumb pain) were calculated using 2-tailed independent *t* tests. The 2-tailed independent *t* test was used for pinch strengths between the cases and the controls. The association of tenderness in different areas of the thumb with other variables like NPRS and hypermobility was analyzed using the Mann-Whitney *U* test. Bivariate logistic regression analysis was performed to find association between various variables. The independent variables that were included were those that were statistically significant ($P < .05$) in the Student *t* test for independent samples. $P < .05$ was considered significant for all the tests.

Results

The flow of patients through the study can be seen in Figure 1; 98% of the participants were right-hand dominant. All of them primarily used only 1 hand for text messaging and occasionally both hands, but the dominant hand was used more for texting.

The duration of usage of the phone by the cases was 31 ± standard deviation 17.6 months and that of the control group 28.9 ± standard deviation 17.3 months, which was not significant ($t = 1.25$, $P = .21$) between the 2 groups. But the number of messages sent per day by the cases and the controls was significantly different between the 2 groups (Table 1). A significant correlation was also identified between age and the duration of phone usage ($r = 0.18$, $P = .05$).

Clinical Examination

Pain. On NPRS, pain was reported by the cases from 0 to 8 with the median at 4 and an interquartile range of 3. A total of 97.5% of cases (n = 114) had mild to moderate levels of pain (0-7 on NPRS) (Table 2).

Tenderness. Out of the 117 cases, tenderness was noted in 43 participants (37%) in all the 3 joints of the thumb. In 22 participants, tenderness was also noted in the web space on deep palpation of the soft tissue, and in 7 participants, it was

Table 1. *Number of Messages Sent by Cases and Controls*

Group	N	Minimum	Maximum	Mean ± Standard Deviation	Median	Zα	P
Cases	117	2	200	66.0 ± 50.6	55	6.9	.00
Controls	117	0	150	27.4 ± 31.8	15		
Total	234	0	200	46.7 ± 46.4	25		

Table 2. *NPRS for Pain Intensity by Cases*

NPRS	Male	Female	Total
0-3	32 (55.2%)	22 (37.3%)	54 (46.2%)
4-7	25 (43.1%)	35 (59.3%)	60 (51.3%)
>7	1 (1.7%)	2 (3.4%)	3 (2.6%)

NPRS, Numeric Pain Rating Scale.

Table 3. *Distribution of Tenderness in the Thumb: Total Number of Participants (Cases) = 43*

Joint	CMC	MCP	CMC + MCP	IP	MCP + IP	Snuff Box	Web Space
Frequency	12	12	8	5	6	22	34
Percentage	28	28	19	12	14	51	79

CMC, carpometacarpal; *IP,* interphalangeal; *MCP,* metacarpophalangeal.

Table 4. *Pinch Strength Variations Between Cases and Controls*

Group	Mean ± Standard Deviation	t	P
Lat r			
Cases	12.7 ± 4.3	2.3	.02[a]
Controls	14.0 ± 4.3		
Tip r			
Cases	9.4 ± 3.6	3.1	.002[a]
Controls	10.9 ± 3.9		

Lat, lateral pinch; *r,* right; *Tip,* tip pinch.
[a] Significant at $P < .05$.

accompanied with tenderness in the MCP joint. Some participants (n = 22) complained of pain only on deep palpation of the bone in the snuff box (Table 3). Altogether, there were 74 students who had tenderness at 1 or more joint with or without tenderness in the snuffbox and the web space. Both MCP and CMC joint tenderness had significant relation to pain (MCP joint: Zα = 2.4, $P = .01$; CMC joint: Zα = 3.3, $P = .001$).

Range of Motion. There was no restriction in the active or passive range of motion in the joints of the thumb.

Hypermobility. The mean score was 2.6 ± 2.6 and the median 2 (interquartile range 0-5). Hypermobility had no significant association with the tenderness noted at the CMC joint (Zα = 0.18, $P = .8$) and the MCP joint (Zα =1.8, $P = .06$).

Table 5. *Mean Difference in Grip and Pinch Strength Variations Between the Left and Right Sides*

Group	N	Measurement Evaluated	Mean Difference ± Standard Deviation	t	P
Cases	117	Grip	2.5 ± 6.9	3.8	.001[a]
		Lateral pinch	0.24 ± 1.7	1.5	.14
		Tip pinch	0.64 ± 1.5	4.6	.001[a]
Controls	117	Grip	2.65 ± 5.6	5.1	.001[a]
		Lateral pinch	0.69 ± 1.7	4.3	.001[a]
		Tip pinch	0.56 ± 1.4	4.3	.001[a]

[a] Significant at $P < .05$.

Table 6. *Logistic Regression of Factors Associated With Thumb Pain*

Variable	Odds Ratio (95% CI)	P
No. of messages	5.78 (2.90-11.49)	.001[a]
Tip pinch	0.89 (0.7-1.13)	.33
Lateral pinch	1.22 (1.001-1.496)	.04[a]

CI, confidence interval.
[a] Significant at $P < .05$.

Table 7. *Characteristics of Patients With Positive Ultrasound Findings*

Ultrasound Positive for MCP Joint	Tenderness at MCP Joint	Tenderness in Web Space	Tenderness in Snuff Box	Grind Test Positive
Participant 1	✓			✓
Participant 2	✓	✓		
Participant 3	✓	✓	✓	✓

MCP, metacarpophalangeal.

Special Test. The grind test was positive in 21% of the cases.

Grip and Pinch Strengths. There were no significant differences in grip strength $t = 1.7$, $P = .11$) between the cases and controls. Tip pinch had highly significant changes ($t = 2.3$, $P = .002$) bilaterally between the 2 groups. Lateral pinch was significantly more affected in the cases compared with the controls ($t = 3.1$, $P = .02$) (Table 4). Compared within the groups between the right and left sides, all measurements were significantly different except for lateral pinch, which was not significant in the cases (Table 5).

Risk

The number of messages sent per day by the students represented a 5.78-fold probability of getting thumb pain with mobile phone usage. The probability of pinch strength becoming affected is shown in Table 6.

Fig 2. *Index finger supporting the phone while text messaging.*

The functional outcome scale DASH was noted within normal range with a score of 10.2. A negative correlation was identified between the DASH scores and the grip strength, but it was not significant (r = –0.115, P = .24).

Ultrasound Evaluation

Cases. All participants (n = 74) in whom tenderness was identified either in the joints of the thumb or the snuff box and the web space underwent ultrasound evaluation to note any subclinical changes that may have been present. Fluid was seen in the MCP joint in 3 participants. The tenderness noted in these participants varied considerably (Table 7). Interestingly, the grind test was positive in 2 of these participants but no changes were seen in the CMC joints, nor were changes noted in the IP joints. A ganglion was seen in the snuff box in 1 other participant in addition to these 3 participants.

Controls. There were 107 participants of 117 controls who volunteered to undergo ultrasound evaluation. Ultrasound evaluation was negative for all participants. Clinically nobody reported pain and no obvious findings identified in the cases were identified in the controls.

Discussion

Fry[30] described the "overuse (injury) syndrome" as "those changes brought about in the muscle and joint ligaments from excessive use causing pain, loss of function, and almost always demonstrable tenderness in the affected structure." Other synonyms for overuse (injury) syndrome are repetitive strain injuries, upper extremity musculoskeletal disorders, upper limb disorders, and upper limb pain syndrome.[31] Regular use of text messaging over a long period could cause repetitive strain, which may lead to both short-term and long-term injuries. The stress is concentrated on the thumb when texters use their hands to hold the small phone and operate it with the thumb while the index finger supports the phone (Fig 2).

The thumb is not a very dexterous digit.[32] It is good at grasping but not good for repetitive movement. The thumb is responsible for 40% of the function of the hand. It is relevant for performing the precision, pulp-to-pulp, tripod, and key grips. Pain, deformity, or malfunction of a thumb will therefore have significant consequences on overall hand function.[33]

Tenderness at the Joints

In our study, tenderness was noted at the MCP joint (60%, 26/43) in the maximum number of participants who had joint tenderness. Metacarpophalangeal joint pain has also been reported more by physiotherapists who practice manual therapy (using the thumb for mobilization), compared with the CMC and IP joints.[9-11] Potential sources of pain at the MCP joint include the proper and accessory collateral ligaments, the volar plate, and the joint capsule. In our study it was determined that the thumb was kept in abduction and opposition at the CMC joint while texting, but to type out the text, the participants had to flex the thumb at the MCP joint and the IP joints (Fig 3A and B). These joints must flex further more if the keys are placed lower down on the mobile (Fig 4). With the newer version of phones, the screen has become big and the keys have become smaller, crammed up in the small space down below the screen. In a study done by Ong[4] it was reported that thumb flexion-extension occurred mainly in the IP and MCP joints during text messaging. The maximum flexion at the IP joint was 20.2° at the asterisk key * (Fig 4) and 18.3° at the pound key # for the MCP joint (Fig 4). The incidence of peak force was reported to link to high flexion angle of the IP joint and in thumb opposition of MCP joint. The force falling on the MCP joint increases as the flexion at the MCP joint increases. They also reported that abduction and adduction of MCP and CMC joints were smaller than flexion-extension and thumb opposition.[4] In another study by Gustafsson et al[34] it was reported that thumb position while entering an SMS message places the thumb in abduction and flexion relative to the adducted and extended thumb posture assumed when talking. Consistent with these findings, our participants kept the thumb in abduction and opposition with flexion at the IP and MCP joints. This could have led to stress at the MCP joint and thus caused tenderness. In addition, MCP joint pain has also been reported in physiotherapists performing posteroanterior (PA) pressures. Thumb alignment was studied in these physiotherapists who had thumb pain during performance

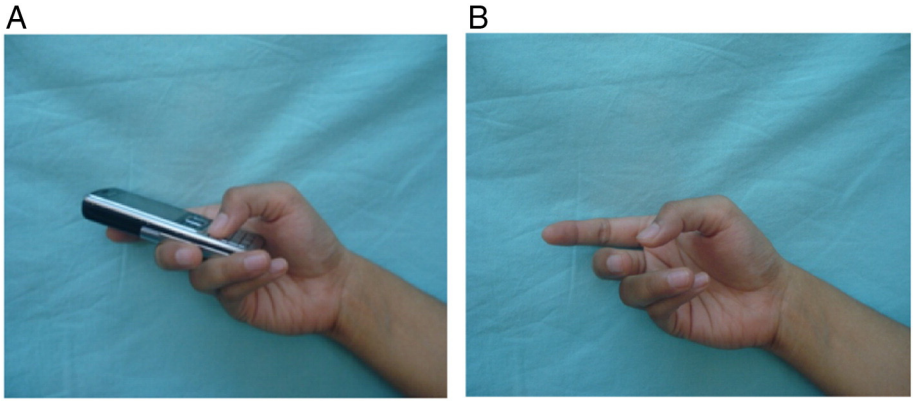

Fig 3. *Abduction and opposition at the carpometacarpal joint with flexion at the metacarpophalangeal and interphalangeal joints. (A) Position with the phone; (B) position without the phone.*

of PA pressures. It was reported that extension of the MCP and IP joints during performance of PA pressures was least likely to be associated with thumb pain. This alignment minimizes tendon and joint moment arms promoting optimal joint loading and maximizing the surface area of joint contact. In our participants the reason for the tenderness identified at the MCP joints could be that these joints are kept in a flexed position while text messaging on the phone.[11]

It has also been reported that pinch may create substantial valgus stress on the ulnar collateral ligament.[35] Texting on the cell phone may have caused stress on the ulnar collateral ligament, and this stress increases as the thumb moves from the right column of the phone to the left side of the phone—keys 1, 4, 7, and * (Fig 5). This may also be 1 reason for tenderness at the MCP joint. Another important finding in our study was that the involvement of the MCP joint was also detected by ultrasound in 4% of the cases. Hence, there may be a correlation among MCP joint involvement, pinching activity as in texting, and ulnar collateral ligament stress that needs to be investigated further in cell phone users. So far, acute injury to the ulnar collateral ligament has been reported in skiers' thumb, which results from valgus stress to the ligament applied by the handle of the pole while falling.[35-38]

Web space tenderness (in 79% of participants) could be due to the fatigue of the muscles with overuse of the thumb for text messaging. Texting, like computer keying, is low-intensity loading on the muscles of the hand. This may have led to damage in these muscles causing the tenderness as seen in computer typing.[39-41]

Tenderness at the CMC joint was identified in 20 participants (47%). At the CMC joint, there are 5 supporting ligaments, which combine with the extrinsic and the intrinsic muscles to maintain stability.[42] It was postulated that irritation to either the joint or the muscular structures may be responsible for the aggravation of pain in the thumbs of manipulative physical therapists.[9] In our study, the repetitive movements of the thumb as in text messaging may have caused irritation to these structures, producing pain and tenderness.

According to Jonsson et al,[43] osteoarthritis at the base of the thumb was more common in participants with features of articular hypermobility (Beighton score 2). Pathologic conditions at the CMC joint were significant in participants who were determined to have hypermobility using the Beighton score. In our study, also the Beighton score reported was 2, but statistically no correlation was identified with CMC or MCP tenderness. The increased flexion that occurs at the IP joints when text messaging may have caused the tenderness at the IP joints.

Grip and Pinch Strength. Grip strength and lateral pinch are commonly employed indices of strength used in hand evaluations.[44] Grip strength measurements are a collective measure of patient's overall strength or weakness.[45] In our study, there was no difference in grip strength between the 2 groups (with thumb pain and without thumb pain).This indicates that there was no overall decrease in the hand strength. Pinch strength measurements are often used clinically to quantify weakness of the thumb[46-48] and are a useful determinant of thumb function.[49] The decrease in the lateral and tip pinches in the cases indicates that the strength of the thumb was decreased in the cases. The lateral pinch was not significantly affected between the left and the right sides in the cases, which indicates that the affected side— the right hand, in most cases—was affected. Further pinch actions have also been identified as the most responsible for inducing symptoms of CMC joint arthritis.[50] Usually key pinch is associated with high forces falling on the CMC joint and leading to arthritic changes on the joint.[31,43] Though the grind test was positive in 21% of participants, there was no

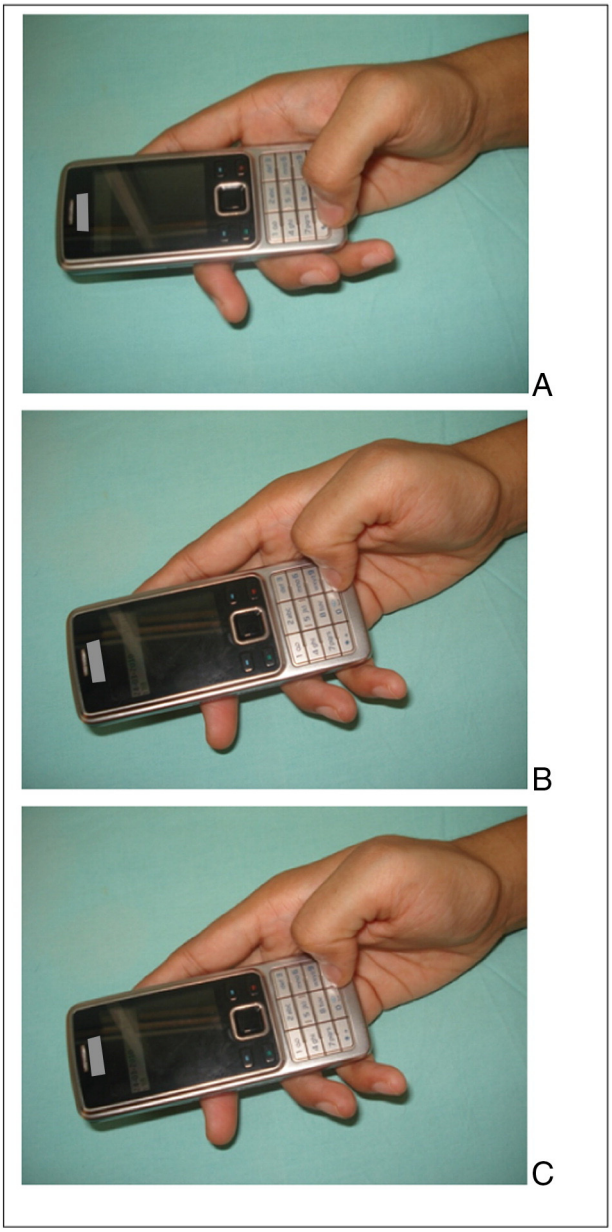

Fig 4. *(A) Flexion increases at interphalangeal and metacarpophalangeal joints to type text at the lower end of the phone. (B) Position of the thumb at key *. (C) Position of the thumb at key #.*

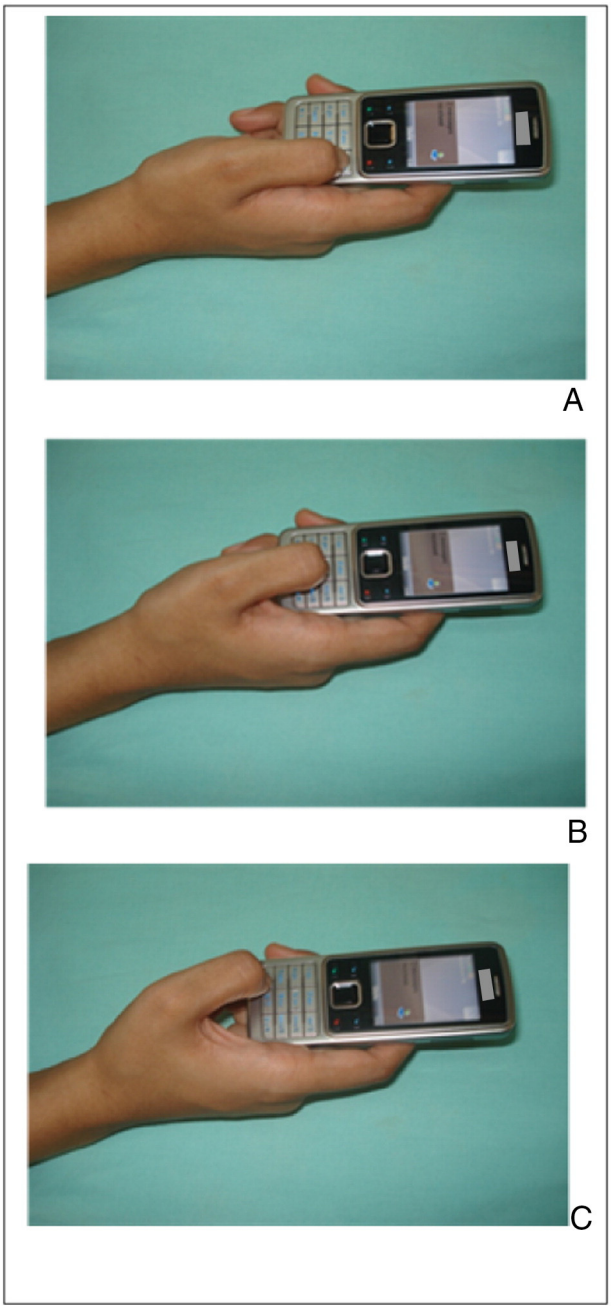

Fig 5. *Increasing valgus stress on the ulnar collateral ligament as the thumb moves from the right column (A) to the middle (B), then to the left column of the phone (C).*

evidence of synovitis associated with the CMC joint reported by diagnostic ultrasound. Flatt[38] pointed out in his study that "adults using mobile phones punch out numbers with their thumbs and develop synovitis in their carpometacarpal joints." It is likely that our study population was young, and degenerative changes are not expected at this age. This could, however, be a risk factor for CMC joint arthritis in those of our population who continue to message later in their life also. Among the manual physical therapists practicing spinal manipulation, it was reported that MCP joint pain was more common in the younger therapists. With increasing age and progressing instability associated with years of spinal manipulative therapy techniques performed through a hypermobile MCP joint, the pain was likely to move toward the CMC joint.[9] The decrease in the lateral and tip pinches in the cases indicates that the strength of the thumb was decreased, but DASH was within normal limits and indicates that it caused little difficulty in the functions of daily living.

Limitations

The design of the phones used by the participants was not considered in this study, and the different phone types could have had an influence in the presentation of symptoms in these participants. Another limitation was that the hypermobility and joint laxity of the thumb joints was not evaluated separately. Overall hypermobility was checked according to the Beighton scale. We identified no association with tenderness noted in the joints of the thumb. It has been proposed, however, that joint laxity and hypermobility at the CMC joints may cause thumb pain and lead to CMC joint arthritis.[9,12] However, in our study the MCP joint was more involved than the CMC joint. Sometimes clinical finding may be present in asymptomatic participants also. No clinical examination was done for the control group, which is another limitation of this study.

Conclusion

The joints of the thumb were determined to be affected in all the students who had thumb pain as a result of mobile phone use. The ultrasound findings were negative for CMC involvement in spite of tenderness at the CMC joint in 47% participants and a positive grind test in 21% of participants.

Funding Sources and Conflicts of Interest

No funding sources or conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): C.E., B.K.
Design (planned the methods to generate the results): C.E., B.K.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): C.E., B.K., A.K.B.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): C.E.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): C.E.
Literature search (performed the literature search): C.E.
Writing (responsible for writing a substantive part of the manuscript): C.E.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): C.E., B.K., A.K.B.
Ultrasound evaluation: A.V.

Practical Applications

- Excessive use of mobile phones with texting can lead to pain and tenderness in the thumb.
- The MCP joint appears to be affected more than the commonly thought CMC joint.
- Excessive texting increases the risk of thumb joint pain 5-fold.

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