

The Effects of Hand Function on the Angle of Holding a Smartphone

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스마트폰 사용 시 팔의 지지 각도가 손의 기능에 미치는 영향

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Abstract The purpose of the study is to prevent pain and malfunction of the hand by correcting the angle of holding a smartphone. Subjects comprised of 21 healthy students. This research was conducted from April 21 2014 to April 27 2014. The three groups were as follows: first group included 7 students who held the phone at an angle of 90 degrees without a sling, and second group included 7 students who held the smartphone at an angle of 90 degrees with a sling; and the third group included 7 students who held the smartphone at an angle of 120 degrees with a sling. VAS was measured through the Finkelstein Test. Also, pain rating and muscle strength were assessed four times 30 minutes before and after the experiment for one and a half hour with pinch grip, dynamometer, and visual analogue scale. Smartphone was used. In all of the measurements, period showed a significant difference ($p<.05$) between both sides and a significant difference was not found between the group. In the time \times group, pain score and grip strength were significantly different in the right side only ($p<.05$). According to the results of this experiment, providing support to the hand helps to increase the hand function by reducing the stress.

요 약 본 연구는 스마트폰 사용 시 팔의 지지 각도에 따라서 엄지손가락과 나머지 손가락의 기능에 미치는 영향을 알아보 고자 하였다. 이 연구는 2014년 4월 21일부터 27일 까지 진행되었다. 연구 대상자는 21명의 건강한 성인을 대상으로 하였으 며, 총 3그룹으로 나누어 진행하였다. 지지대 없이 90도의 각도를 유지하고 스마트 폰 타자를 실행한 그룹, 슬링을 이용하여 90도 각도를 유지하고 스마트 폰 타자를 실행한 그룹, 슬링을 이용하여 120도 각도를 유지하고 스마트 폰 타자를 실행한 그룹으로 나누었으며, 각 그룹은 7명씩 나누었다. 손의 통증을 측정하기 위하여 핀켈스타인 검사를 하였으며, 시각 통증 척도 를 이용하여 결과를 나타내었다. 또한 손의 악력과 엄지손가락의 핀치 그립을 측정하였다. 각 측정은 왼손과 오른손을 측정하 였으며, 시작 전, 30분, 1시간, 1시간30분으로 총 4번 측정하였다. 본 연구의 결과는 왼손과 오른손의 통증, 악력, 핀치 그립의 시기에서 유의한 차이를 보였으며($p<.05$), 오른손의 악력에서는 시기와 군의 교호작용에서 유의한 차이를 보였다($p<.05$). 이 결과로 인하여 팔의 지지는 손의 스트레스를 줄여 손의 기능에 도움을 준다고 생각된다.

Keywords : Grip Strength, Hand function, Pinch grip, Smartphone, Visual analogue scale

1. Introduction

In our personal life, we may find that we are increasingly utilizing and relying on smartphones[1]. User interface data in June 2007 suggest that there are 9.6 million smartphones, PDAs, and Blackberry devices

in use. From 2007 to 2011, worldwide shipments of mobile devices are expected to grow at a compound annual rate of 54 percent, yielding an estimated 82 million mobile devices in use by 2011. With the recent release of Apple iPhone and LG Prada Samsung

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Galaxy (primarily touchscreen devices), and others likely to follow, thumb use for mobile touchscreen applications is likely to increase[2]. Mobile communication has become an integral part of daily communicative practices of users through telephony, web access, and applications (apps). Mobile communication, a communication behavior that enables the users to be mobile without the need for wired communication is performed via the mobile phone, tablet, or laptop. The most widely distributed and used mobile communication device to date is the smartphone. The utility of the smartphone has been increasing rapidly since it is being used in every aspect of an individual's life. To name a few, the smartphone is used in medical science, and for safety purposes[3].

The hand has unique features like any other organ of the body in everyday life, and functional impairment of the hand can affect everyday life and ultimately the quality of life. The length of the upper limbs and shoulder, the location and shape of the elbow is primarily designed to perform the function of the hand, and the shoulder, upper arm, and elbow are not a part of the hand, the hand is not directly related to Hands and unique characteristics like any other organ of the body in everyday life, functional impairment can wear a very delicate structure affect the issue of life and ultimately the quality of life appeared. The length of the upper limbs and shoulder, the location and shape of the elbow is primarily structured to indicate the function of the hand and the shoulder, upper arm, elbow is not part of the hand, the hand is directly related to[4].

The human hand is composed of the thumb, index finger, middle finger, ring finger, little finger, and the palm, which includes the thenar eminence, the hypothenar eminence, and creases. The fingers consist of 19 bones of distal phalanges, middle phalanges, and proximal phalanges, and metacarpal bones. Thus, the fingers have metacarpophalangeal (MCP), proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints, whereas the thumb has carpometacarpal (CMC),

MCP, and interphalangeal (IP) joints. The wrist contains the following eight bones: the hamate, pisiform, triquetral, capitate, lunate, trapezoid, trapezium, and scaphoid. In total, the hand has 27 bones and 28 muscles[5]. These various bones and muscles enable the hand to perform various functions. The hand is frequently used in activities of daily living and industrial fields because of its many functions.

The hand grip and pinch grip is an important and basic function for various movements. Object manipulation with a stable handgrip is one of the most frequent movements performed in activities of daily living and occupational fields. A reduction in the grip strength and control ability can be attributed to physical and psychosocial factors[6].

In recent times, studies of hand kinetics analyzed the force, moment, and torque of the fingers and tendons. These studies used a tendon-force- measurement system[7], force transducers[8], dynamometers[9], force gloves[10], and pinch gauges[11] to take measurements. The tendon forces from the extrinsic muscles of the hand have been measured directly by instrumenting the tendon[12].

The purpose of the study is to prevent pain and malfunction of the hand by correcting the angle of holding a smartphone.

2. Methodes

2.1 Subjects

This research was conducted from April 21 2014 to April 27 2014. There was no specific illness or pain in the past medical or surgical evaluation and for management of non-specific diseases of the hand and wrist, 21 mentally and physically healthy students were recruited in our study. All of the subjects agreed to participate in the experiment. The study was conducted in three different groups of students of "H" university in Gwangyang, Jeollanam-do province, South Korea [Table 1].

Table 1. General characteristics of the subjects (N=21)

	Age (years)	Weight (Kg)	Height (cm)
I (N=7)	22.34 ± 1.25	59.42 ± 9.48	169.42 ± 7.91
II (N=7)	22.14 ± 1.17	54.28 ± 8.19	163.85 ± 8.49
III (N=7)	23.17 ± 1.64	56.57 ± 9.45	168.71 ± 9.28
p	.901	.149	.208

I : non-sling
 II : 90° with sling
 III : 120° with sling

2.2 Experimental design

Subjects comprised of 21 healthy students and they were divided randomly into three groups. These three groups were as follows: the first group, a control group [Fig. 1-A]; the second group included 7 students who held the phone at an angle of 90 degrees without a sling, and 7 students who held the smartphone at an angle of 90 degrees with a sling [Fig. 1-B]; and the third group included 7 students who held the smartphone at an angle of 120 degrees with a sling [Fig. 1-C]. The sling helps to fix the angle of the hand and VAS was measured through the Finkelstein Test. Also, the pain rating and the muscle strength were assessed four times 30 minutes before and after the experiment for one and a half hour with pinch-grip, dynamometer, and visual analogue scale. Smartphone (G2, LG, Korea) was used. Typing was performed via a smartphone app [fig. 1-D].

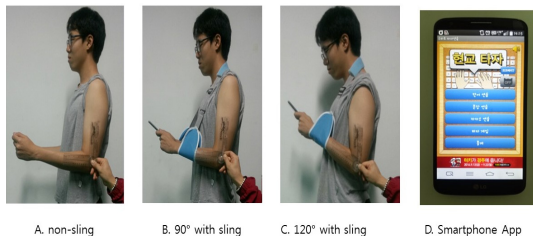


Fig. 1. Group setting and smartphone application

2.3 Experimental methods

2.3.1 Pain measurement

Finkelstein test was used to measure the pain in

hands, visual pain scale was used to measure the pain (visual analogue scale: VAS), and it was conducted during the Finkelstein test. Finkelstein test is performed to assess pain when the thumb is bent inwards in a state of wrist ulnar deviation.

2.3.2 Grip strength

Grip strength was measured using a North Coast bulb dynamometer (North Coast, California, United States) with participants seated, their elbow by their side and flexed to right angles, and a neutral wrist position, the dynamometer handle position II and provision of support underneath the dynamometer. This position, followed by calculation of the mean of three trials of grip strength for each hand, has been well-documented as reliable[13].

2.3.3 Pinch grip

The palmar pinch was selected because it is one of the most frequently evaluated types of pinch. Pinch grip was measured with a B&L pinch gauge (model PG-30; B&L engineering, Sante Fe Springs, California) following the recommendations of the American Society of Hand Therapists for the standardized position[14].

2.4 Statistical analysis

SPSS software, version 20.0 (SPSS, IBM, USA) was used to analyze all collected data. The analysis of covariance (ANOCVA) of variance test was performed to determine intergroup differences. Statistical significance was set at a *p* value of less than .05.

3. Results

3.1 Change in VAS during the Finkelstein test

In the examination of the VAS, period showed a significant difference (*p*<.05) in both sides, and a significant difference was not found between the group.

In the time \times group, change in VAS was significantly different in the left side only ($p < .05$) [Fig. 2]. In the post-hoc analysis over time, across all time showed a statistically significant difference compared to except pre and 30 minutes for the right side.

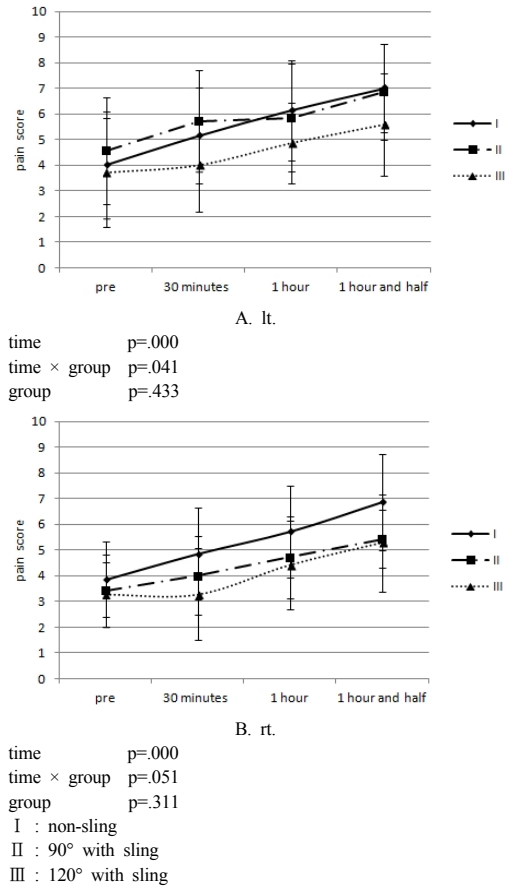


Fig. 2. Change in VAS during the Finkelstein examination (lt. & rt.)

3.2 Change in the grip strength

In the examination of the grip strength, period showed a significant difference ($p < .05$) in both sides, and a significant difference was not found between the group. In the time \times group, change in the grip strength was significantly different in the right side only ($p < .05$) [Fig. 3]. In the post-hoc analysis, across all time showed a statistically significant difference between both sides.

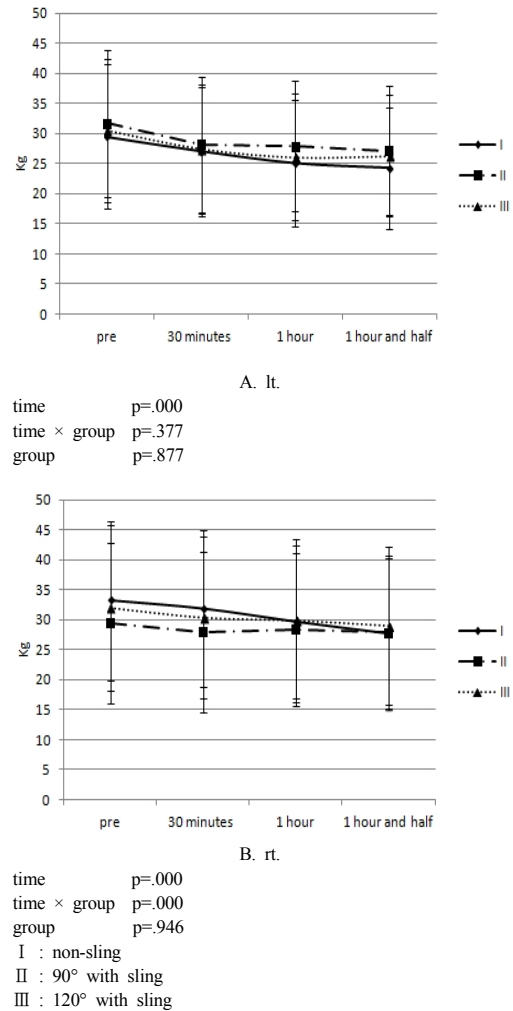


Fig. 3. Change in the grip strength (lt. & rt.)

3.3 Change in the pinch grip

In the examination of the pinch grip, period showed a significant difference ($p < .05$) in the group, in the time \times group, change in the pinch grip was not significantly different [Fig. 4]. In the post-hoc analysis, across all time showed a statistically significant difference in the left side. In the right side, pre and 1 hour, pre and 1 hour 30 minutes, 30 minutes and 1 hour 30 minutes, and 1 hour and 1 hour 30 minutes showed a statistically significant difference.

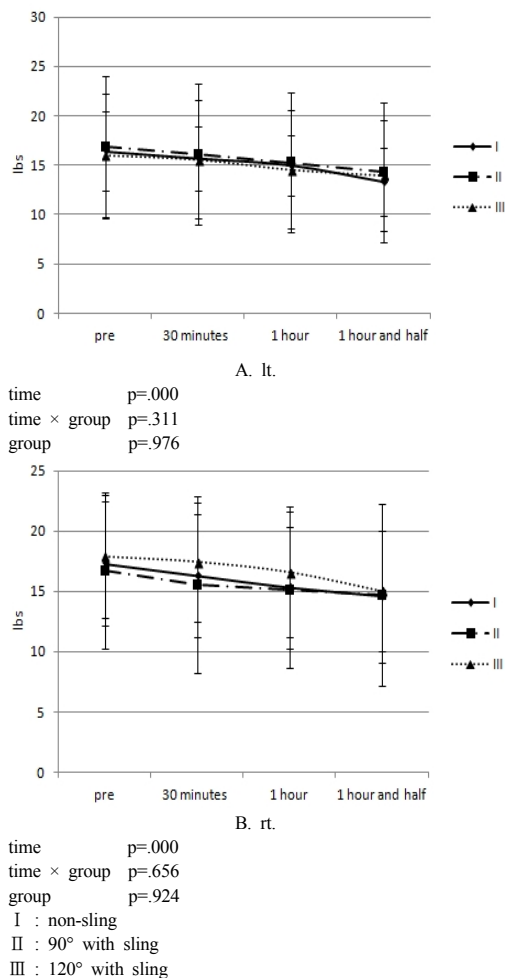


Fig. 4. Change in the pinch grip (lt. & rt.)

4. Discussion

The aim of this study was to evaluate the effect of the support provided by the sling on the pain and function of the hand due to the repetitive use of the smartphone. Injuries to the wrist and hand were the most prevalent. Other commonly injured areas were the upper back and low back and neck[15]. In the studies of hand pain due to repetitive tasks, Kim (2013) showed that the hand grip was reduced. The B & L Engineering Pinch Gauge Hydraulic Hand Dynamometer was used in this study for measuring the

grip strength and holding power in order to evaluate the function of the hand. It can produce data related to testing etiologic models and treatment interventions[16].

With respect to the use of some smartphone applications, research evidence suggests the appropriateness of the prescribed range of motion exercises, including active palmar abduction of the thumb and proprioception, for individuals with trapeziometacarpal (TMC) arthrosis. The pain and decreased range of motion experienced by these individuals interfere with the hand function[17] and are related to the progression of TMC arthrosis[18-20]. There is a relationship between decreased pain and improvement in physical function, stiffness, and perception of symptom impact on status in individuals with hand osteoarthritis (OA), thus pain should be the primary concern when treating patients with OA[21].

Change in pain in the Finkelstein test showed a significant difference in the timing for both the right hand and the left hand. A significant difference was not found between the groups. However, when supported by the sling, a reduction in most aspects of the pain was observed than in the non-sling group. There was a less increase in the pain in the 90° sling group than in the non-sling group. The 120° sling had the greatest effect in the group. In the examination of the VAS, period showed a significant difference ($p < .05$) in both sides, and a significant difference was not found between the group. In the time × group, change in VAS was significantly different in the left side only ($p < .05$).

The VAS is a convenient, reliable, well-validated instrument for self-reporting that has been used in behavioral sciences for over 80 years[22]. The hand grip is an important and basic function for various movements. Object manipulation with a stable hand grip is one of the most frequent movements performed in activities of daily living and occupational fields. A reduction in the grip strength and control ability can be attributed to physical and psychosocial factors. Physical factors can include a reduction in the number of

contracting muscle fingers, reduction in the firing rate of motor units, and change in the muscle fiber type. Psychosocial factors can include pain, a fear of pain, and a fear of re-injury. Pain can reduce the grip force, which decreases voluntary muscle activity[6].

Change in grip strength showed a significant difference in the timing for both the right hand and the left hand ($p < .05$). A significant difference was not found between the groups. In the time \times group, change in grip strength was significantly different in the right. However, when supported by the sling, a reduction in most aspects of the pain was observed than in the non-sling group. There was a less decrease in grip strength in the 90° sling group than in the non-sling group. The 120° sling had the greatest effect in the group. In the examination of the pinch grip, period showed a significant difference ($p < .05$) in the group. In the time \times group, change in pinch grip was not significantly different.

Pinch strength measurements are often used clinically to quantify weakness of the thumb. Previous studies have demonstrated that PS measurements obtained with a pinch gauge have a high test-retest reliability and a high inter-rater reliability in healthy subjects[23]. High inter-rater reliability has also been found in subjects with cumulative trauma disorders[24]. There was a less decrease in pinch grip in the 90° sling group than in the non-sling group. The 120° sling had the greatest effect in the group. In the examination of the pinch grip, period showed a significant difference ($p < .05$) in the group. In the time \times group, change in pinch grip was not significantly different.

Even though the smartphone is used for social connections and interactions, what leads to continuous use is self-actualization rather than self esteem. until now, research on smartphone use is lacking. The support arm of the mouse, there is research that reduces the load on the hand, but research is not at all related to the smartphone. Because of the study, I hope that more research being done.

This study showed that there was a decrease in

muscle loading on the hand, when a sling was applied. At the lowest torque value of 120°, the muscles of the hand showed the maximally reduced load lifting aspect. The study of the supporting arm according to the angle of the arm showed the effect of reducing the pain in the hand, it was confirmed that to reduce the hand of the depression.

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