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NEÜ YAYINEVİ

Is Glenohumeral Joint Proprioception Affected by Hand Preference?

Glenohumeral Eklem Propriosepsiyonu El Tercihinden Etkilenir mi?

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Öz

Amaç: Bu çalışmanın amacı tercih edilen ekstremitenin glenohumeral eklem hareket hissi ile tercih edilmeyen ekstremitenin hareket hissi arasında fark olup olmadığını incelemektir.
Gereçler ve Yöntem: Çalışmaya omuz ekleminde herhangi bir problemi olmayan, sağlıklı, sedanter 20 kişi (10 erkek, 10 kadın) dahil edildi. Katılımcıların yaş ortalaması 23,60±3,64 yıl idi. Veriler 6 Temmuz 2020 ile 3 Ağustos 2020 tarihleri arasında toplandı. Katılımcıların tercih edilen ve tercih edilmeyen taraf glenohumeral eklem hareket hissi ölçüldü. Hareket hissi ölçümü izokinetik dinamometre kullanılarak, 0,1°/s açısal hızda pasif hareket hissi eşik değeri ölçülerek belirlendi. Hareket hissi ölçümleri, 0°'den (0°-IR) ve 30°'den (30°-IR) internal rotasyon yönüne ve 0°'den (0°-ER) ve 30°'den (30°-ER) eksternal rotasyon yönüne olmak üzere 4 yöne doğru yapıldı.
Bulgular: Katılımcıların tercih edilen taraf için internal rotasyon hareket hissi eşik değerleri 0°-IR, 30°-IR açı ve yönleri için sırasıyla 1,27±0,47°, 1,30±0,45°, eksternal rotasyon hareket hissi eşik değerleri 0°-ER, 30°-ER açı ve yönleri için sırasıyla 1,25±0,39°, 1,41±0,32° ve tercih edilmeyen taraf için internal rotasyon hareket hissi eşik değerleri 0°-IR, 30°-IR açı ve yönleri için sırasıyla 1,33±0,59°, 1,37±0,49°, eksternal rotasyon hareket hissi eşik değerleri 0°-ER, 30°- ER açı ve yönleri için sırasıyla 1,39±0,49°, 1,18±0,42° idi. Her iki tarafın pasif hareket hissi eşik değerleri arasında farklar istatiksel olarak anlamlı değildi ($p<0,05$).
Sonuç: Çalışma sonuçlarına göre tercih edilen ve tercih edilmeyen ekstremitelerin omuz propriosepsiyonu farklı değildir. Omuzu ilgilendiren yaralanmaların rehabilitasyonunda propriosepsiyona ilişkin hedef; yaralanmış ekstremitenin tercih edilen veya tercih edilmeyen olmasına bakılmaksızın sağlam taraf omuz propriosepsiyonuna göre belirlenebilir.

Anahtar Kelimeler: Kinestezi, glenohumeral eklem, tercih edilen el.

Abstract

Aim: The purpose of this study is to examine whether there is a difference between the sense of movement of the glenohumeral joint of the dominant extremity and the sense of movement of the non-dominant extremity.
Materials and Methods: In the study, 20 healthy and sedentary, volunteer participants (10 males, 10 females) who did not have shoulder problems were included. Mean age of the participants were 23.60±3.64 years. Data collection were performed between July 6, 2020 and August 3, 2020. The sense of movement of the dominant and non-dominant extremities of the glenohumeral joint was measured for the participants. The measurement of sense of movement was done by using an isokinetic dynamometer by measuring the passive sense of movement threshold value at an angular speed of 0.1°/s. The sense of movement measurement was performed towards four directions: from 0° (0°-IR) and from 30° (30°-IR) to internal rotation direction, and from 0° (0°-ER) and from 30° (30°-ER) to external rotation direction.
Results: The sense of movement of the participants for internal rotation at angles and directions of 0°-IR, 30°-IR were respectively 1.27±0.47, 1.30±0.45, and for external rotation at angles and directions of 0°-ER, 30°-ER were respectively 1.25±0.39, 1.41±0.32 for the dominant side extremity, for internal rotation at angles and directions of 0°-IR, 30°-IR were respectively 1.33±0,59°, 1.37±0,49°, and for external rotation at angles and directions of 0°-ER, 30°-ER were respectively 1.39±0,49°, 1.18±0,42° for the non-dominant side extremity. For neither of the two extremities, the differences between the sense of movement were statistically significant ($p<0.05$).
Conclusion: According to the results of the study, shoulder proprioception of dominant and non-dominant extremities is not different. The goal of proprioception in the rehabilitation of shoulder-related injuries; regardless of whether the injured extremity is dominant or not, may be determined according to the shoulder proprioception of the sturdy extremity.

Key words: Kinesthesia, glenohumeral joint, reference hand.

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INTRODUCTION

Neuromuscular control refers to the control of the nervous system over muscle activation. This control is provided by the integration of sensory input (proprioceptive, vestibular, cutaneous, visual, etc.) in the central nervous system. Multisensory input and its integration are vital for the muscular system to function in order (1). Proprioception is afferent information that is collected by mechanoreceptors in muscles, joints and skin and transported to the central nervous system to integrate with other sensory information. In other words, proprioceptive information is sensory input that forms the basis for neuromuscular responses (2). Measuring the activity of mechanoreceptors provides information about proprioception. Detecting the sense of motion in the joint, actively or passively, detecting the angle at which the joint is being actively or passively removed and positioning the joint at that angle again are the most commonly used methods for evaluating the functions of mechanoreceptors (3). Furthermore, the questioning of changes in joint speed and muscle strength provides information about joint proprioception (4, 5). It is claimed that proprioception is affected by certain factors such as age (6), gender (7), physical activity level (8), type of physical activity (9), musculoskeletal injuries (10) and extremity preference (11).

Some studies report that the preference of the extremity affects the proprioception of both the upper extremity and lower extremity joints (12,13). Some research for the upper extremity indicates that the proprioceptive acuity of the upper extremity joints, which is non-dominant, is better. These studies suggest that the non-dominant extremity stabilizes the body, object, etc. during the functions of the dominant upper extremity, which provides this extremity with an advantage in terms of proprioceptive feedback (14,15). On the other hand, there is research suggesting that the dominant upper extremity is better than the extremity, which is non-dominant in terms of dynamic proprioceptive acuity (16,17). As it turns out, the information on this subject is not yet clear. Therefore, the effect of hand preference on upper extremity joints should be investigated more and more thoroughly. In line with this information, the study aims to examine whether there is a relationship between hand preference and sense of motion in the glenohumeral joint (GHJ).

MATERIALS AND METHODS

The study was carried out with the participation of 20 (10 women and 10 men) students from Necmettin Erbakan University Faculty of Health Sciences. Inclusion criteria of the study; It was to be between the ages of 18-25 and to be healthy. Criteria for exclusion from the study were having suffered from shoulder injuries, having undergone shoulder surgery, having general joint laxity and participating in sports (basketball, volleyball) that regularly involve overhead activities, spinal disease related to cervical or thoracic vertebrae, having a disease that concerns the peripheral and/or central nervous system, and using psychoactive or vasoactive drugs.

The research was carried out according to the Helsinki Declaration and the ethics committee approval was taken according to the decision no. 2020/2629 of the Meeting no. 110 dated June 19, 2020. Participants' upper extremity preferences were determined by the Edinburgh Hand Preference Survey (18), whether there was a general joint laxity by the Beighton Scoring (19) and whether there was a musculoskeletal injury involving the upper extremity by the Quick Disability of the Arm, Shoulder and Hand Questionnaire (Q-DASH) (20).

Edinburgh Hand Preference Questionnaire

Edinburgh Hand Preference Questionnaire was used to determine the upper extremity preferences of the participants. It is a questionnaire applied to determine hand preferences, questioning the hand or hands used in performing 10 different hand activities during daily activities, and depending on this, it is used to decide whether the person can use his left hand, right hand or both hands (21). In the Turkish reliability study of the questionnaire, it was stated that the questionnaire had excellent reliability for the Turkish population (18).

The Beighton Score

The presence of general joint laxity of the participants was determined by using the Beighton Score. In this scoring, the lowest score is 0 and the highest score is 9. A total score of 4 and above indicates general joint laxity (19).

The Disability of the Arm, Shoulder and Hand Questionnaire (Q-DASH)

The Q-DASH was used to determine whether the participants had a musculoskeletal injury involving their upper extremities. This questionnaire has been shown to be a valid and reliable questionnaire that measures physical function and symptoms in patients with upper extremity problems, answered by the patient himself, Turkish validity and reliability studies were conducted. It includes 11 topics extracted from the DASH survey. At least 10 of the 11 items must be answered in order for the Q-DASH score to be calculated. Each title contains 5 answer options, the score of the scale is calculated from the title scores (0, no disability, 100, most severe disability) (20).

Proprioception measurement was performed with an isokinetic dynamometer. Before measurements, the system was calibrated according to the manufacturer's instructions and recommendations (22). For the measurement of proprioception, glenohumeral joint (GHJ) internal (IR) and external (ER) rotation direction sense of motion test was used (23). Initially, each participants was given a comprehensive explanation of the methodology of the study and instructions on the way of communication with the researcher during the tests (22). Participants warmed up for 5 minutes with active range of motion exercises before the tests (24). After the warm-up period, the participant lay on his back on the isokinetic dynamometer device. To reduce sensorial input, the extremity to be measured was inserted into a pneumatic splint and placed on the dynamometer with the elbow at 90º flexion and the shoulder at 90º abduction. Visual and auditory input was eliminated using eye patches and headphones (22,25). First, the measurement of the dominant extremity, then the measurements of the non-dominant extremity were made.

Within the scope of motion sensation measurement, the isokinetic dynamometer (Cybex Humac Norm CSMI, New YORK, USA) passively moved the extremity in the direction of IR or ER at a speed of 0.1°/s. The participant was asked to express whether he felt the motion to the individual who tested the motion as soon as he first felt it. The time between the moment the test started and the moment the participant felt the motion was recorded in seconds. Measurements were made in the following positions and directions; 0º to IR direction, 30º IR position to IR direction, 0º to ER direction and 30º ER position to ER direction. Each measurement was repeated three times, and the average of the three measurements was recorded as a sense of motion test result.

Statistical Analysis

The data was uploaded to the computer environment and analyzed with "SPSS (Statistical Package for Social Sciences) for Windows 22.0 (SPSS Inc, Chicago, IL)". Participants' GHJ sense of motion test results were grouped as dominant and non-dominant extremity. Descriptive statistics were presented as median (interval between quarters), frequency distribution and percentage. The suitability of variables to normal distribution was examined using visual (histogram and probability graphs) and analytical methods (Shapiro Wilk Test). Mann-Whitney U Test was used as a statistical method for statistical signification between two independent groups for variables that did not conform to normal distribution. The level of statistical significance was considered $p<0.05$.

RESULTS

The average age, height and weight of the participants were respectively; 23.60±3.64 years, 1.70±0.11 meters and 71.60±14.05 kilograms. Demographics are presented in Table 1. The proportion of those who preferred their right hand was 80% (n=16), while the proportion who preferred their left hand was 20% (n=4).

Results of sense of motion in 0°-IR, 30°-IR, 0°- ER, 30°-ER angles and directions of participants; were 1.27±0.47, 1.30±0.45, 1.25±0.39, 1.41±0.32 degrees for the dominant extremity and 1.33±0.59, 1.37±0.49, 1.39±0.49, 1.18±0.42 degrees for the non-dominant extremity respectively ($p<0.5$, Tablo 2).

Table 1. Demographic characteristics of the participants

	Age (year)	Height (cm)	Weight (Kg)	BMI (Kg/cm^2)
Min-Max	20.00-32.00	156-186	52.00-99.00	17.99-33.08
Mean±SD	23,60±3,64	1.70±0.11	71.60±14.05	24.49±3.34

Table 2. Preferred and non-preferred extremities' GHJ sense of movement

	GHJ of preferred extremity (n=20) Mean±SD	GHJ of non-preferred extremity (n=20) Mean±SD	Z*	p
0°-IR	1.27±0.47°	1.33±0.59°	-0.606	0.579
30°-IR	1.30±0.45°	1.37±0.49°	-0.266	0.796
0°-ER	1.25±0.39°	1.39±0.49°	-0.457	0.684
30°-ER	1.41±0.32°	1.18±0.42°	-0.683	0.529

GHJ: Glenohumeral joint, IR: Internal Rotation, ER: Eksternal Rotation,* Mann Whitney U Test

DISCUSSION

Results of the study planned to examine whether the dominant and non-dominant GHJ sense of motion test results are different in young adult individuals; GHJ joint IR and ER sense of motion showed that the test results were not different.

Visual and proprioceptive feedback is critical for targeted motion (11,26). The central nervous system is familiar with the proprioceptive acuity of both upper extremities during motion. Nevertheless, it controls motion using proprioceptive information of the extremity, which it finds more reliable than proprioceptive knowledge of the two upper extremities it has (27). Deciding which proprioceptive information from the dominant upper extremity or the dominant upper extremity is important, which is depend on which of the learned motion patterns the person uses (28). Nevertheless, it is unclear and confusing at which of the dominant or non-dominant upper extremities the acuity of mechanoreceptors providing proprioceptive input to the upper centers is better. While some studies report that the proprioceptive acuity in the mechanoreceptors of the non-dominant upper extremity is better, others report better proprioceptive feedback from the mechanoreceptors of the dominant upper extremity. Methodological differences such as the measured joint, measured direction of motion and the measured variable can be cited as the cause of this contradiction (14-17).

In the measurement of shoulder proprioception, similar to other joints, it can be used in combination with tests such as sense of position, sense of motion, force reproduction and motion speed reproduction. The most reliable tests to measure the sensitivity of the mechanoreceptors are sense of passive position and sense of motion tests performed isokinetic dynamometer to IR and ER direction in 90 degree abduction (23). Nevertheless, it is known that the sense of motion test is more reliable in testing proprioception due to the fact that it represents afferent proprioceptive sensory processing processes better and it demonstrates the contributions of passive structures to the process better (29, 30). Many of the studies that provided information about dominant and non-dominant shoulder proprioception tried to conclude by examining the results of sense of position tests, but there was no consensus (14-17). Kumar CG S et al. (17) reported that in healthy young individuals, sense of motion acuity of shoulder joint rotation direction was better in the dominant extremity compared to the non-dominant one. Echalier C et al. (16) demonstrated that the results of sense of position tests for the flexion and abduction direction of the dominant extremities for healthy participants between the ages of 16 and 54 were better than that of the non-dominant extremity. Han J et al. (14) tested the proprioceptive acuity of the dominant and non-dominant lower and upper extremities of 12 participants with an average age of 21±4 with active motion extent discrimination apparatus. The researchers reported that the participants' non-dominant extremity results were more successful in shoulder-related tests than dominant extremity results. Schmidt L et al. (15) reported that the non-dominant shoulder active sense of position tests of participants between the ages of 20 and 70 were better than the dominant extremity. As far as we know, there is no research comparing the dominant and non-dominant sense of shoulder motion in healthy individuals. The only study that gave an idea was the study of Allegrucci M and colleagues in which they examined 20 participants with an age average of 18.8±1.3 engaged in upper extremity sports that involve the dominant use of a single extremity. The results of the study revealed that the sense of passive shoulder joint motion in the non-dominant extremity is better than the sense of passive shoulder joint motion in the dominant extremity. It has been suggested that kinesthetic deficits that may have developed in the dominant extremity, which is more commonly used in throwing activity, affect these results (31). The most important and previously unexposed result of this study is that the dominant and non-dominant and undesirable extremity GHJ sense of passive motion test results in healthy young individuals are not different from each other. Depending on this result, it can be inferred that mechanoreceptors that receive the passive joint sense of motion of dominant and non-dominant extremities do not differ functionally. Contrary to the results of previous studies (14-17), which claimed that dominant or non-dominant extremity shoulder proprioception was better based on sense of position tests, it can be concluded that the dominant and non-dominant shoulder proprioception is not different according to the results of this study (14-17). Although methodological differences appear to be the most important reason for this contradiction, the results of the study can also be interpreted as a review of the conclusions that proprioception of the dominant or non-dominant extremity reached by sense of position tests is better.

It has been reported that functional deficiencies caused by glenohumeral joint pathologies are not affected by hand preference (32-34). Razmjou H et al. (32) reported that preferred side involvement was not associated with higher disability in individuals with glenohumeral joint osteoarthritis. Kelly MA et al. (33) reported that the functional outcomes of preferred and non-preferred-side rotator cuff repair were similar. Lim CR et al. (34) reported that there is no relationship between traumatic shoulder dislocation and hand preference. Current study results suggest that GHE proprioception in healthy shoulders is not different. However, investigating hand preference and proprioception in subgroups with pathological involvement may contribute to a better understanding of the subject. In addition, hand preference, propriceptive acuity and how this is reflected in functional results in individuals with shoulder pathology may be another intriguing issue.

There are some limitations to this study. The fact that the participants are from a certain age group will prevent the generalization of the study results for children and the elderly. Future studies can research the effect of childhood and old age processes on dominant and non-dominant upper extremity GHJ proprioception. Another limitation is that GHJ proprioception is evaluated only by sense of motion test. However, proprioceptive feedback consists of the sum of afferent information from many mechanoreceptors. In future studies, the conclusions on the subject can be strengthened by expanding the work by adding tests such as force reproduction and reproduction of the speed of motion. In addition, the results of the study will be insufficient to reveal how GHJ proprioception is affected after surgery and injuries related to GHJ. New research on this topic will help make the subject more understandable.

CONCLUSION

According to the results of the study, shoulder proprioception of dominant and non-dominant extremities is not different. The goal of proprioception in the rehabilitation of shoulder-related injuries; regardless of whether the injured extremity is dominant or not, the sturdy side can be determined according to shoulder proprioception.

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