



## Effect of taping on scapular kinematics of patients with facioscapulohumeral muscular dystrophy

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### Abstract

The aim of this study is to investigate the effects of scapular taping on scapular kinematics by three-dimensional electromagnetic system during shoulder elevation in facioscapulohumeral muscular dystrophy patients. A total of 11 patients with facioscapulohumeral muscular dystrophy were included in the study. Scapular anterior-posterior tilt, upward-downward rotation, and internal-external rotations were evaluated using the three-dimensional electromagnetic system during the elevation of the upper limbs in the scapular plane before and after kinesio taping. For maximum humerothoracic elevation, there were no differences between the patients before and after taping on both dominant ( $p = 0.72$ ) and non-dominant sides ( $p = 0.64$ ). For scapular internal rotation, upward rotation, and posterior tilt, there were no differences between patients before and after taping during humerothoracic elevation on both dominant and non-dominant sides ( $p > 0.05$ ). These results showed us that the excessive and abnormal movements of the scapula observed during the humeral elevation in facioscapulohumeral muscular dystrophy patients cannot be supported with flexible methods like kinesio taping. Therefore, we recommend to evaluate the scapula position by applying flexible and rigid taping to the patients who can reach over 90° in humerothoracic elevation in future studies.

**Keywords** Facioscapulohumeral muscular dystrophy · Scapular kinematics · Three-dimensional analysis · Upper extremity · Scapulohumeral muscles · Kinesio taping

### Introduction

Facioscapulohumeral muscular dystrophy (FSHMD) is an adult muscle disease characterized by the onset of involvement of face and scapula stabilizer muscles and proceeding with the weakening of the lower extremity and pelvis area muscle. One of the most frequently observed problems is scapular winging that occurs as a result of the thoracoscapular muscle weakness and the weakness of the muscles around the shoulder. In case the deltoid is relatively preserved, the scapula moves away from the chest wall during the elevation of the shoulder with the rotation [1, 2]. As a result of this, loss of strength occurs in the glenohumeral joint; and it becomes

difficult to sustain the flexion and abduction of the shoulder [3]. A bad situation occurs with pain [4] in terms of cosmetics with the limitation of the daily life activities like combing the hair, brushing the teeth, and laying down. For this reason, preventing the scapular winging in FSHMD means a more efficient deltoid function and the increase in the life quality [5].

The stabilization of the scapula is important for upper extremity functions. The primary goal in patients with scapular winging is to sustain scapular stabilization. For this purpose, approaches like orthosis [6, 7] and fixing the scapula to the chest wall are used in FSHMD patients [5]. Orthoses only ensure that the stabilization is sustained during use; and since they are heavy, the use of them is not common [8]. Although fixing the scapula to the thoracic cage in a surgical manner is a method used more commonly, it has many complications [5].

In studies conducted on shoulder and scapula problems, another method used to position and support the scapula is the taping method [9]. Kinesio tape is a flexible tape found by Kenzo Kase and is used for various therapeutic purposes [10]. Kinesio tape is an adjunct

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application used in healthcare, rehabilitation, and sports [11]. One of the most important functions of Kinesio tape is to lift the skin and thus support the blood circulation and lymphatic flow [12, 13]. This principle is used to reduce the swelling in the trauma area in order to accelerate the redistribution of hematoma [10]. Kinesio tape is also designed to ensure a free range of motion and joint stability. It is also applied differently for muscle inhibition and muscle strength. In addition, Kinesio tape is known to have positive effects on pain. In a study, it was shown that kinesio tape had positive effects on pain, muscle force, and joint ROM in individuals with knee OA [14]. In addition, it is stated in the literature that Kinesio tape is a preventive intervention in the control of postural spinal curvature disorders [15].

There are many studies in which Kinesio tape was used for various shoulder [16] and upper extremity injuries [17], in athletes [18], in neurological diseases [19–23], and in healthy individuals [24]. Scapular taping was used in these studies to ensure mechanical correction, increasing proprioceptive input, and increasing neuromuscular control.

When the literature is examined, no applications were detected except for the orthosis and surgical fixation for the support of scapular stabilization in FSHMD patients. When the effects of taping are examined, it is believed that it may help the positioning of the scapula and facilitate the upper extremity movements of patients. We also think that taping may be advantageous because it is not an application which causes heavy weight like orthosis and does not require surgical intervention. For this purpose, our study was planned to investigate the effects of scapular taping on scapular kinematics in FSHMD patients.

## Materials and methods

This study was performed at Hacettepe University, Faculty of Physical Therapy and Rehabilitation, Neurological Rehabilitation Unit. The approval was obtained from the Hacettepe University, Non-interventional Clinical Researches Ethical Board (approval no: GO 16/156). The individuals were informed about the aims of the study, the evaluations, taping and the informed consent forms were signed and approved. A total of 11 volunteers who were diagnosed by the neurologist with facioscapulohumeral muscular dystrophy (FSHMD) as a result of EMG and muscle biopsy were included in the study.

Inclusion criteria of the study are as follows:

- Having FSHMD diagnosis
- Being above the age of 18
- Not having any other neurological or orthopedic diseases
- Not having cognitive problems or cooperation difficulties

Exclusion criteria of the study are as follows:

- Having previous fracture, connective tissue and muscle injury, and joint problems that may affect the upper extremity
- Having scapular fusion operation

The demographic data of the 11 FSHMD patients were recorded. The evaluation of scapular kinematics was performed by the three-dimensional electromagnetic system. Then, Kinesio tape was applied to the right and left scapula of the patients and the evaluations were repeated. The data were analyzed according to the dominance state.

## Demographic data

The demographic data of the FSHMD patients who were included in the study (age, gender, height, weight, dominant side) were recorded.

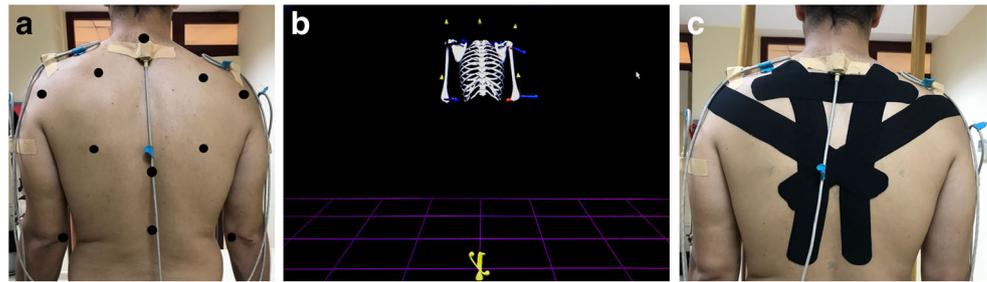
## Kinematic evaluation of the scapula with the 3-D analysis method

The scapular kinematic evaluations of the patients were made during the elevation of the upper extremities on the scapular plane by using 3-D electromagnetic system (Motion Monitor® Skeleton Analysis System, Innovative Sports Training Inc., Chicago, USA). During evaluations, firstly, the movement sensors were made ready, and the areas where the sensors would be placed on the body of the individuals were marked. Five sensors that had  $1.9 \times 3.3 \times 3.5$ -cm size were used for the analysis. These sensors were applied to the bilateral acromion posterior side, to the insertion of the bilateral deltoid muscles, and to the first thoracic vertebra by using double-sided adhesive tape [25, 26] and were fixed with non-flexible tapes (Fig. 1a).

The sixth sensor was attached to the sharp-point marking device. The patient was asked to stand up so as his/her face would show the positive x-axis. The bone process recommended by the International Society of Biomechanics and used in a proper manner was marked and digitalized according to the protocol [27]. After the digitalization was completed, the simulative image was obtained (Fig. 1b).

The scapular kinematic data of the individuals during the arm elevation on the scapular plane were recorded. During the measurements, the individuals were asked to hold their thumbs upwards, to do the arm elevation in 3 s by following the metronome on the defined plane, and lower their arms in 3 s. A metronome at 60 beats per minute (bpm) was used to maintain a constant speed of  $30^\circ/\text{sec}$ . Three measurements were taken on the scapular plane, and the mean of these measurements was recorded. Among the scapular kinematic data that were obtained, the scapular anterior-posterior tilt (X

**Fig. 1** Analysis of scapular kinematics. **a** Location of sensors and digitization points. **b** 3-D image of the patients after digitization. **c** Kinesio taping



plane), up-down rotation (Y plane), and internal-external rotation (Z plane) movements of the patients which exceeded  $30^\circ$ ,  $60^\circ$ , and  $60^\circ$  were selected at the maximum humerothoracic elevation. In the analysis, the movements of the scapula with respect to the position of the thorax were determined by using the Y-X-Z Euler angle range [27].

The type of data was rotational data, and the filter design was the Butterworth filter. For the axis assignments, the y-x'-z' sequence was used to define scapular rotations. The first rotation defined the amount of the internal-external rotation, the second one defined that of the upward-downward rotation, and the last one defined that of the anterior-posterior tilt. The motion monitor software was used for the analysis.

### Taping application

The taping was made to the individuals with FSHMD who participated in the study by an experienced physiotherapist. For the postural correction, three pieces of I-shaped elastic band with a width of 5 cm were applied (Kinesio Tex Gold; Kinesio, LLC, Albuquerque, NM, USA). The first I-shaped band was applied to control the position of the scapula, until the medial borders of the scapula by crossing the glenohumeral joint starting from the coracoid process. The second I-shaped band was applied towards the paravertebral muscles starting from the middle and lower parts of the trapezius muscle to facilitate the upright position and ensure proprioceptive input. The third I-shaped tape was applied to the interscapular area below C7 to ensure scapular adduction in an upright position (Fig. 1c). The length of the tapes was decided by measuring the start and end points when the patient was in the anatomic position.

### Statistical analysis

The statistical analyses were performed using SPSS software version 22.00 (SPSS Inc., Chicago, IL, USA). The variables determined by measurements were expressed in terms of the arithmetic mean and SD values. Scapular kinematics at  $30^\circ$ ,  $60^\circ$ , and maximum humerothoracic elevation during the elevation of the arm was analyzed. The Wilcoxon rank test was

used to compare scapular upward-downward rotation, internal-external rotation, and anterior-posterior tilt before and after taping. The significance level was set at 0.05.

### Results

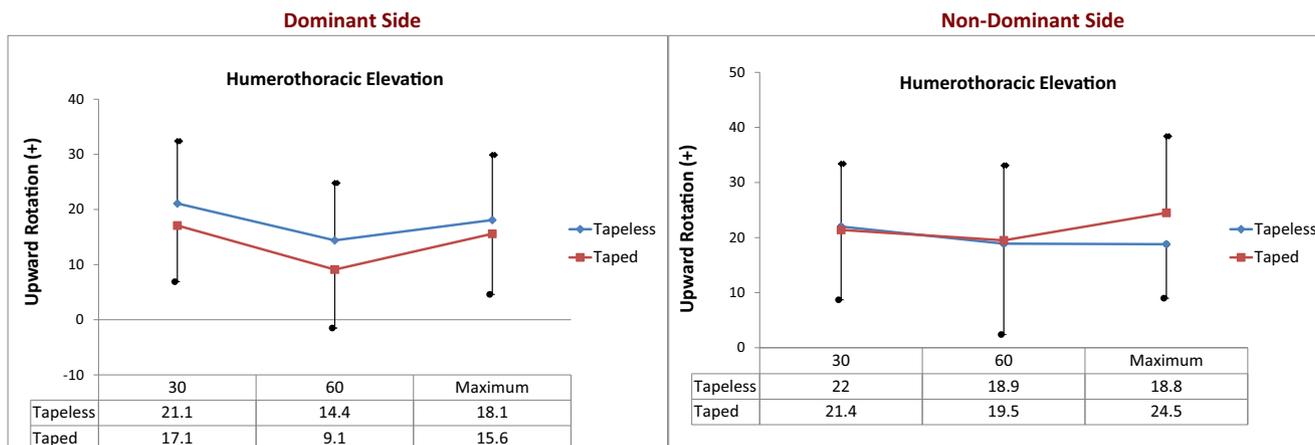
Eleven patients (five males and six females) with FSHMD were included in the study (age 34.09 years, height 169 cm, and weight 62.72 kg; nine of the patients were right-handed and two of them were left-handed).

The maximum humerothoracic elevations of patients before and after taping on the dominant side were  $70^\circ \pm 19.9^\circ$  and  $69^\circ \pm 18.9^\circ$  and on the non-dominant side  $69.7^\circ \pm 24.8^\circ$  and  $58.9^\circ \pm 25.6^\circ$  respectively. There were no differences between the patients before and after taping on both dominant ( $p = 0.72$ ) and non-dominant sides ( $p = 0.64$ ).

For scapular internal rotation, upward rotation, and posterior tilt, there were no differences between patients before and after taping during humerothoracic elevation on both dominant and non-dominant sides ( $p > 0.05$ ). Scapular kinematic data and maximal humerothoracic elevation of the patients with FSHMD before and after taping are presented in Fig. 2.

### Discussion

In this study, it was observed that the Kinesio tape did not have any effect on the correction of the disrupted scapular patterns in FSHMD patients. The stabilization of the scapula, which transmits the energy produced in the body to the arms, is important for correct kinetic chain function [28]. During shoulder movements, the weakness of the thoracoscapular muscles, which provide the control of the scapula over the chest wall, causes scapular winging. This situation, which appears in many neuromuscular diseases, is associated with the weakness of thoracoscapular muscles weakness, and with the general weakness of the shoulder muscles. While slight scapular winging is observed in many neuromuscular diseases, the thoracoscapular muscle weakness appears in the early period together with the relative protection of the deltoid



**Fig. 2** Scapular internal/external rotation, upward/downward rotation, and anterior/posterior tilt during dominant and non-dominant side shoulder elevation of patients with FSHMD (with and without taping)

strength in FSHMD. During the elevation of the shoulder, the scapula moves away from the chest wall, the individual cannot continue the movement, and this situation causes the patient to have problems in the activities of daily life. When the strength of the other muscles of FSHMD patients is relatively preserved, and the long life spans of these patients are considered, the scapular stability becomes important for active functioning of the deltoid muscle and to ensure the quality of life [3].

In our study, which was carried out to examine the scapular positions of the patients with FSHMD during humeral elevation [29], we observed that there were a more lower rotation, internal rotation, and posterior tilt when compared with healthy individuals. It was reported that the most affected muscles at the highest level were trapezius, serratus anterior, and latissimus dorsi in MR studies conducted on patients with FSHMD [30, 31]. When the fact that the movements of the scapula are ensured primarily by serratus anterior and trapezius muscles is considered, the weakness of these muscles explains these excessive and abnormal movements that appear in the scapula. The abnormal position of the scapula results in the increased load that affects the tissues by causing mechanical dysfunction in proximal segments. For this reason, proximal stability is disrupted and the strength produced in the distal segments is affected [32].

The scapular taping has been the subject of many studies, with the transfer of the energy in the body towards the upper extremity, the decrease of pain and the correct functioning of the upper extremities. In these studies, it was demonstrated that scapular taping contributed positively to the scapula during humeral elevation [33], it might be used for protective purposes in risk groups [24] and it was effective on the scapular kinematic [16]. We could not receive significant results in the present study which we conducted to bring scapular movements closer to normal in terms of the movements by taping the scapula. Although the scapular movements that were

observed in the humeral elevation after the taping in the patients were slightly closer to normal, this did not cause a significant change in the abnormal patterns observed during the movement. These results showed us that the excessive and abnormal movements of the scapula observed during the humeral elevation in FSHMD patients cannot be supported with taping and the stabilization cannot be ensured in this way. Other studies using scapular taping were generally conducted on healthy individuals and athletes. Taping was reported to have positive contributions to scapular movements in these studies. This positive effect may be explained by the fact that the muscular structure of the individuals in these studies was actually healthy, and the scapular position was corrected by ensuring correct proprioceptive input and mechanical correction with taping. Our study group, i.e., the FSHMD, is a group of patients with a problem in muscle physiology. This problem which exist in muscle fibers, causes that adequate muscular force is not produced. Therefore, it is not possible to correct the position of the scapula only with taping. The Kinesio tape has a flexible structure. The methods used in FSHMD patients to support the scapula are more “rigid” methods. For this reason, using a more rigid tape may yield different results.

In previous studies, different taping methods were used to position the scapula [24, 33]. The taping method used in our study was similar to that used by Turgut et al. [17]. Turgut et al. positioned the scapula following a distal radius fracture and examined the scapula position during humeral elevation and lowering with 3D kinematic analysis. They demonstrated that the scapula moved more to external rotation and posterior tilt after the taping and the application preserved this position, which supported the optimal function of the rotator cuff in the early period.

In our study, the fact that the FSHMD patient group we evaluated was not much homogenous is a limitation of our study. Since this disease is not observed frequently, we

included all the contacted patients who met our inclusion criteria in the study. Another limitation is that the number of patients who could reach over 60° in humerothoracic elevation was low. We believe that an analysis that will be conducted with more patients who can reach over 90° humerothoracic elevation will provide more accurate results about the position of the scapula. For this reason, we recommend that the scapula position is evaluated by applying flexible and rigid taping to patients who can reach over 90° in humerothoracic elevation and who are at the early stage of the disease.

## Conclusions

According to the results of our study, Kinesio tape did not have any effect on the correction of the disrupted scapular patterns and did not cause a significant difference in the abnormal patterns observed during the movement in FSHMD patients. However, we believe that an analysis that the scapula position is evaluated by applying flexible and rigid taping to patients who can reach over 90° in humerothoracic elevation and who are at the early stage of the disease will provide more accurate results about the position of the scapula.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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