ACTA UNIVERSITATIS CAROLINAE
KINANTHROPOLOGICA Vol. 49, No. 2 – 2013 Pag. 23–31

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ACTIVE AND PASSIVE THERAPY OF THE UPRIGHT POSTURE AND ITS INFLUENCE ON THE HEMODYNAMICS OF THE UPPER LIMBS

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SUMMARY

Poor posture negatively influences the hemodynamics of the upper extremities. In clinical practice, this is known as Thoracic outlet syndrome. Poor posture leads to muscle imbalances which are solved with the active exercise or using the passive technique – taping. This work is an experimental pilot study dealing with the kinematics and taping of the cervical-thoracic spine and their influence on the hemodynamics of the upper extremities. Ten subjects aged 26 ± 2 years, weight 56 ± 4 kg, height 161 ± 8 cm (mean ± SD) without pathology or injury of the shoulder girdle and spine were recruited. First part of subjects (5 persons) externally rotated the arms. During this exercise the kinematic analysis was used for determining the extension of the thoracic spine. Another part of subjects (5 persons) used the taping of rhomboids and pectoralis minor muscles. The hemodynamics of the axillary artery was determined with the sonography at both groups. The taping improves the hemodynamics of the upper extremities easier than the active exercise, which should be done with the control of the physiotherapist.

Keywords: hemodynamics, upright posture, thoracic kyphosis, axillary artery, taping

INTRODUCTION

The change of lifestyle with a technological development leads to a reduction in physical activity (Morris et al., 2006). Many authors deal with poor posture in children and adults (Kratěnová et al., 2007; Šeráková, 2006). Poor posture is reflected in people with long-term forced working position (usually in sitting position). It leads to pushed-forward head position, rounded and depressed shoulders and to increasing of the thoracic kyphosis. This position places stress on the spine (Berthonnaud et al., 2011). In this passive poor posture the body saves the energy, because ligaments are more activated than muscles (Véle, 1995). Faulty posture is the source of many disorders and affects on the mental state, digestive system, breathing, hemodynamics of the upper extremity and musculoskeletal system.

Thoracic kyphosis is created during a child growth – the mobility and the shape of thoracic spine decrease. Almost 30% of children do not have optimal static settings

of spinal segments (Kolář et al., 2005). The thoracic kyphosis is dependent on physical activity – the thoracic kyphosis increases without sport activity and its mobility decreases. The function of the axial system is linked with the function of the upper limbs (Véle, 1997). In persons with hyperkyphosis both shoulders and upper thoracic spine motions become limited. The thoracic hyperkyphosis decreases muscular strength of the upper limbs and conversely (Lewit, 2003). Cheshomi et all (2011) concluded that increasing of the curvature of thoracic kyphosis causes the protraction of the scapula and endurance of posterior shoulder girdle muscles decreases. The muscles of the shoulder girdle are closely related to the muscles of the spine. DiVeta was interested in poor posture. Forward shoulders are the result of an imbalance between shortened or stronger pectoralis minor muscles and an elongated or weaker rhomboids and middle trapezius muscles (DiVeta et al., 1990). The decrease of the thoracic hyperkyphosis is described by Smíšek (Smíšek et al., 2011) whose patients are trained in retraction of the scapula, adduction and external humeral rotation.

Poor posture negatively influences the hemodynamics of the upper extremities. Thoracic outlet syndrome occurs in patients with thoracic hyperkyphosis other disorders of the cervicothoracic spine (Collins, 2003), The kyphosis rotates the scapulae anterior laterally, clavicles anteriorly, displaces the manubrium posteriorly, which increases the slope of the first ribs. This increases tension on the anterior scalene muscles and the neurovascular bundles. Thoracic outlet syndrome is caused by compression of a nervous and vascular (suclavian, axillary artery) plexuses in the area of upper thoracic aperture (Podlaha, 2007). Rehabilitation therapy usually includes correct posture, elevation of the thorax and shoulder girdle, the compensation of excessive lordosis, kyphosis and outstanding scapulae. Due to the rehabilitation, the symptoms disappeare in up to 50% of patients (Zatočil, 1997).

PURPOSE

The purpose of this pilot study is to evaluate the effect of the upright posture on improving the hemodynamics of the upper extremities. Poor posture is described as depression of the thorax, thoracic hyperkyphosis with rounded shoulders and protraction of the scapulas. This can be therapeutically solved with the active exercise or passively using the taping technique. The external rotation and adduction of the shoulder leads to the upright posture of the cervical-thoracic spine (Jelínková, 2012). Do these postural changes lead to a change of hemodynamics in the axillary artery? Is the active exercise better than the passive therapy taping for improving the hemodynamics?

METHODS

Subjects

Poor posture is reflected in people with long-term forced working position (usually in sitting position). We selected 10 subjects – 5 cyclists and 5 students without sport activity, aged 26 ± 2 years, weight 56 ± 4 kg, height 161 ± 8 cm (mean ± SD). All were without the pathology or injury of the shoulder girdle and the spine.

Kinematic analysis

The external rotation and adduction of the shoulder was used as the active exercise for the upright posture. In the case of the first group of students, the kinematic analysis (producer Qualisys, 6 cameras Opus, frequency 200 Hz) was used for determining the position of the clavicle, thorax, pelvis and the curvature of the thoracic spine. The markers were placed on the anatomical landmarks as ISB recommended (Anon, 2002; Wu et al., 2005) see Table 1. Subjects did not know the purpose of the study, they did not know the tested movement and they did not learn this movement. Subjects were instructed to perform following task: breath out, externally rotate the arms, hold the elbows at the body and hold the final position for 5 seconds. The subjects did the whole procedure only once. The curvature of the thoracic spine was given with 12 markers on the thoracic vertebrae, calculated as polynomial of the second order in the Excel. The position of the clavicle, thorax (xyphoid process) and pelvis (SIAS) was determined as the translation movement (from the initial position to the final position) in the sagittal plane.

Table 1. Placement of markers

Spine	Spinous process of cervical (C2, 4, 6, 7), thoracic (Th 1–12) and lumbar (L1, 3, 5) vertebrae
Pelvis	Spina iliaca anterior superior (SIAS), spina iliaca posterior superior (SIPS)
Thorax	Clavicle, xyphoid process

Sonography

The second group of 5 cyclists was firstly examined with the ultrasound in a rest sitting position, than the taping technique as a passive therapy of the poor posture was used. Taping was applied on the pectoral minor and rhomboids muscles for 5 hours. Then the hemodynamics of the axillary artery was determined with the ultrasound at both groups. The first group of students underwent the ultrasonography in the final position of the external humeral rotation. The second group of cyclists did the ultrasound examination in a sitting position with the taping. For the sonography the machine Logic C9 (producer GEMS, the linear probe) was used. The flow rate of the artery was determined according to the velocity and the diameter of the artery, $Q = Vm\_mean \times A$. The percentage flow rate was calculated like this equation, $dQ = (Q2 / Q1) \times 100$, where Q1 is the flow rate in the initial position and Q2 is the flow rate in the final position.

RESULTS

The tested movement leads to the extension of the thoracic spine and elevation of the thorax (see Figure 1). The condition of the upright posture is to keep the pelvis in neutral position, to avoid the anteversion of the pelvis which causes the imbalances between abdominal, pectorals and dorsal muscles. Kinematic dates of the group of students are

presented at Table 2, results of the ultrasound examination are in Table 3,4. Results of cyclists are in Table 5, 6. Taping was suitable for all cyclists. Taping can be used for improving the hemodynamics of the upper limbs. The exercise must be done under the control of the physiotherapist to do the optimal upright posture to improve the hemodynamics of the upper limbs.

Table 2. Kinematic values of the group of students

Subject	1	2	3	4	5
Curvature / poor posture	0.0036	0.0030	0.0026	0.0026	0.0024
Curvature / upright posture	0.0030	0.0028	0.0022	0.0030	0.0024
Position of pelvis	posterior 2 mm	anterior 37 mm	posterior 16 mm	anterior 9 mm	anterior 3 mm
Elevation of thorax	anterior 11 mm	anterior 2.5 mm	posterior 2.5 mm	posterior 11 mm	anterior 2 mm
Elevation of clavicula	anterior 12 mm	anterior 2 mm	posterior 2.5 mm	posterior 5 mm	anterior 2 mm

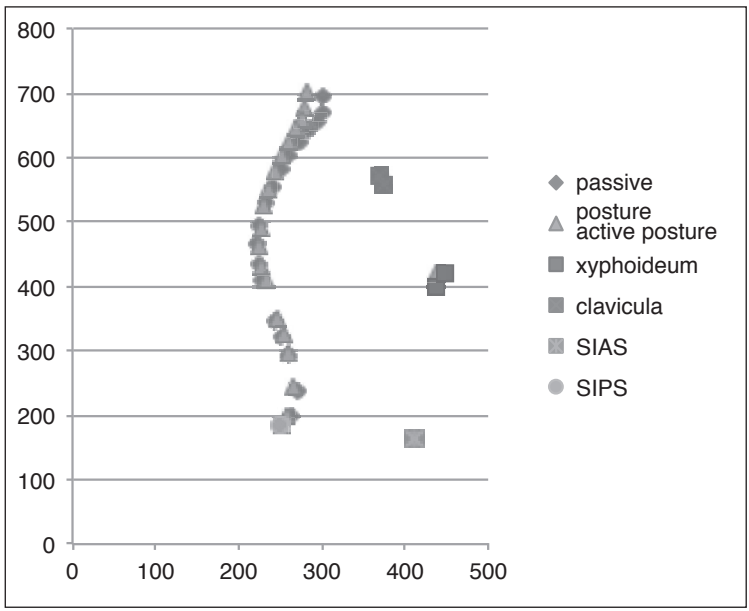

Figure 1. Graph of kinematic values, subject – student 1

Table 3. Measurements of ultrasound, group of students (Vm_mean 1, Vm_mean 2 – mean of velocity, Q1, Q2 – flow rate of artery, A1, A2 – diameter of artery, dQ [%] – percentage flow rate, Q = Vm_mean × A, dQ = (Q2 / Q1) × 100)

Rest position Subject	**A1 [cm^2]**	**Vm_mean1 [cm/s]**	**Q1 [cm^3/s]**
1	0.27	10.80	2.92
2	0.29	13.50	3.92
3	0.22	9.60	2.11
4	0.28	10.20	2.86
5	0.14	10.70	1.50
Final position Subject	**A2 [cm^2]**	**Vm_mean2 [cm/s]**	**Q2 [cm^3/s]**
1	0.26	14.20	3.69
2	0.15	24.80	3.72
3	0.25	11.70	2.93
4	0.22	11.40	2.51
5	0.15	16.10	2.42

Table 4. Results of percentage flow rate of artery, students

Subject	**dQ [%]**
1	126.61
2	95.02
3	138.49
4	87.82
5	161.21

Table 5. Measurements of ultrasound, group of cyclists

Rest position Subject	**A1 [cm^2]**	**Vm_mean1 [cm/s]**	**Q1 [cm^3/s]**
1	0.25	17.00	4.25
2	0.21	13.60	2.86
3	0.32	14.40	4.61
4	0.38	10.00	3.80
5	0.26	14.60	3.80

Taping Subject	A2 [cm^2]	Vm_mean2 [cm/s]	Q2 [cm^3/s]
1	0.23	23.50	5.41
2	0.33	11.00	3.63
3	0.38	18.20	6.92
4	0.34	13.60	4.62
5	0.28	16.20	4.54

Table 6. Results of percentage flow rate of artery, cyclists

Subject	dQ [%]
1	127.18
2	127.10
3	150.09
4	121.68
5	119.49

DISCUSSION

The thoracic hyperkyphosis with protraction of the scapulas is caused with the shortness of pectoral minor muscles and weakness of the rhomboids muscles. The upright posture was solved using taping of rhomboids and pectoral minor muscles as recommended (Thelen et al., 2008). After this passive therapy there was the improving of the hemodynamics of the upper limbs at all the cyclists. Taping is a young form of strapping. It is a new procedure that uses tape, attached to the skin, to physically keep in place muscles or bones at a certain position (Kobrová et al., 2012). There is little scientific evidence that elastic therapeutic taping produces clinically significant benefits. A 2012 systematic review found that the efficacy of elastic therapeutic tape in pain relief was trivial given that no studies found clinically important results. The tape may have a small beneficial role in improving strength, range of motion in certain injured cohorts and force sense error compared with other elastic tapes, but further studies are needed to confirm these findings (Williams et al., 2012). There are several theoretical benefits claimed for the tape. One of those is correcting the alignment of weak muscles as well as facilitating joint motion as a result of the tape's recoiling qualities. Additionally, the tape is claimed to lift the skin, increasing the space below it, and increasing blood flow and circulation of lymphatic fluids. Taping is used on massive hematomas. This increase in the interstitial space is said to lead to less pressure on the body's nociceptors, which detect pain, and to stimulate mechanoreceptors, to improve overall joint proprioception (Bassett et al., 2010). It seems that the taping is easy to use universal passive technique than the active therapy.

During the external rotation and adduction of the shoulder the pectorals muscles are elongated and the rhomboids muscles are activated. After this active therapy there was the extension of the thoracic spine at the first and third student. These subjects did the extension of the thoracic spine. Each body solved the strategy for the upright posture individually. It depends on the initial setting of each body segments. The fifth student had the upright posture in the initial and final position. The thorax and clavicle were elevated during the tested movement which led to the improving of the hemodynamics of the upper limbs.

The curvature of the thoracic spine increased only at the fourth student, this subject was not able to create the upright posture, there was hyperextension of the spine and the clavicle was not effectively elevated as the thorax. Kolář (2005) concluded that the balance must be between pectorals and abdominal muscles to stabilize the thorax in the upright position. Faulty case of extension of the spine is elevation of the thorax and anteversion of the pelvis. This posture is called as Opening scissors syndrome according to Kolář, it is caused due to the imbalance between the pectorals, abdominal and dorsal muscles. This situation led to the deterioration in the hemodynamics of the upper limbs.

The second student created the upright posture, but the clavicle elevated and moved anterior less than the thorax. There was a compression of the axillary artery with the first rib on the sonograph. The hemodynamics of the upper limbs decreased. This final posture of this student is called as the Forward drawn posture according to Lewit – there is the hypertension of the gluteal and the paravertebral muscles, the whole body moved forward (Lewit, 2003).

The position of the cervical-thoracic spine and the upper extremities affects hemodynamics of upper extremities. Many authors have described the obstruction of axillary artery during the abduction of arms. Abduction and external rotation of the upper extremities (arms overhead) posterior inferiorly rotate the clavicles and the subclavius muscle fees which enhances tension on the venous drainage and neurovascular supply that diminishes venous return (James D. Collins, 2003). Conversely, the adduction and external rotation of the shoulder leads to the elevation of the clavicle and improving the hemodynamics if the thorax is optimally stabilized according to Kolář (Kolář et al., 2005).

CONCLUSION

Poor posture negatively influences the hemodynamic of the upper extremities and conversely, the upright posture improves hemodynamics of the upper extremities. External rotation and adduction of the shoulder leads to the upright posture, to the extension of the thoracic spine and to the elevation of the thorax and clavicle. If the clavicle was elevated the same or more than the thorax the hemodynamics was improved. Taping as a passive therapy was suitable for all subjects and led to the improving of the hemodynamics of upper extremities. It seems to be generally easier for use than the active exercise which should be done with a physiotherapist to be effective for the hemodynamics.

ACKNOWLEDGEMENTS

This study was for the research: SVV 2013–267603.

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AKTIVNÍ A PASIVNÍ TERAPIE NAPŘÍMENÍ A JEHO VLIV NA HEMODYNAMIKU HORNÍCH KONČETIN

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SOUHRN

Chabé držení těla vede ke změnám nervově-cévního zásobení horních končetin. Toto je popisováno v klinické praxi jako syndrom horní hrudní apertury. Vadné držení těla je doprovázeno svalovými dysbalancemi, které jsou optimalizovány aktivním cvičením nebo s využitím pasivní techniky – tapingu. Tato práce je experimentální pilotní studií, která se zabývá kinematikou a tapingem cervikothorakálního přechodu a jejich vlivem na cévní zásobení horních končetin. Deset probandů (26 ± 2 let, 56 ± 4 kg, 161 ± 8 cm) bez patologie a zranění pletence ramenního a páteře podstoupilo měření. První část probandů (5 osob) prováděla cvičení – zevní rotace paže. Během tohoto cvičení byla snímána kinematickou analýzou (Qualisys) extenze hrudní páteře. U druhé části probandů (5 osob) byl použit taping rhomboideálních a malého prsního svalu. U obou skupin byla použita sonografie k určení krevního toku arterií axillaris. Taping, jakožto pasivní metoda, zlepšuje cévní zásobení horních končetin jednodušeji než aktivní cvičení, které musí být prováděno pod dohledem fyzioterapeuta.

Klíčová slova: hemodynamika, vzpřímené držení, hrudní kyfóza, arterie axilaris, taping

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