

Laser Tracker - a handy device that verify proprioception of neck and head

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Abstract

Introduction: Cervical spine is characterized by the greatest mobility among other parts of the spine. High mobility and relatively low load which is the subject's neck (own weight, the weight of the head, tension arising from the work of the shoulder girdle) that make it vulnerable injuries and overload resulting from adverse external conditions. Neck pain is a common issue in modern society but the sources of its development can be many. According to many researchers, long-lasting neck pain disturbs afferent nerve conduction perpetuating the abnormal muscle tone in the occiput, neck and shoulder girdle, thus adversely affecting the proprioceptive sensibility in the cervical spine. Stability small disorders can occur many years before the onset of other clinical symptoms, dry as disc protrusions or radiologically confirmed features of disc degeneration, significantly hindering the functioning of patients and Potentially limiting the maximum performance of an athlete.

Study objective: The aim of this study is to present possibilities of using a Laser Tracker, a simple and compact device which is intended to examine and train proprioception within the head and neck.

Conclusion: In the light of the roles that the cervical spine plays for the posture of the whole body and of the fact That proper proprioception is the main pillar of prevention of overload injuries and

determines normal neuromuscular control, it is worth assisting the therapy with a visual feedback. That possibility is given to the Laser Tracker. In the therapeutic practice, it seems to have an invaluable role and further top unlimited options for use.

Key words: joint position sense, deep sensation, proprioception, neck pain

INTRODUCTION

Cervical spine has the greatest mobility of the remaining part thereof. From an anatomical point of view, it protects head and spinal cord along with intervertebral discs and nerves extending through the holes cords. In the category of function it is responsible for the orientation of the head in space and setting it in a way that optimizes the work of the sense organs - especially eyes, but also nose and ears. [15]

High mobility and relatively low load which subjects neck (own weight, the weight of the head, tension arising from the work of the shoulder girdle) make it vulnerable to injuries and overloads resulting from adverse external conditions. However, research of Patwardhan et al., performed under autopsy showed that a properly loaded neck is able to counteract the forces of measuring isometric even 250N [25]. The main aim to provide an effective protection of the neck is to develop a strong muscle tissue with a balance between agonists and antagonists and correct proprioceptive information[5].

DYSFUNCTIONS OF THE CERVICAL SPINE

Neck pain is a common problem of modern society and the sources of its formation can be many. Whether the cause is clear from mechanical trauma, degenerative changes, or overload, the most common symptoms are: increased muscle tone, pain, limitation of movement and discomfort during daily activities^[21,33]. A significant impact on severity, according to respondents, has the physical work (carrying heavy things), stress and long-term intake of forced, abnormal posture [22]. It is estimated that as many as 71% of the general adult population suffers from back pain. Most often complaining are office workers, middle-aged, ie. Above 40 years of age. Scientists also agree that this problem is more common in women than men [5,8,16,23]. What's more, sedentary lifestyle not only promotes the development of pain within the musculoskeletal system, but adverse affects virtually every system of the human body [4].

Another group exposed to considerable overloading of the cervical spine are professional athletes e.g. such disciplines as rally racing, martial arts, rugby players and

participants enjoying a growing popularity of extreme sports. In addition to heavy consequences directly life threatening, such as a concussion and fractures in the spine or skull, which threaten the onset of permanent neurological deficits, players are exposed to severe shock, vibration and repeated with different strength, direct head injuries that are the main cause of micro-injuries and subluxations resulting in joint proprioception deficits and conducive to the appearance of instability within the individual segments of the spine, which in turn leads to the appearance of premature degenerative changes [6,31,32,37].

PROPRIOCEPTION

Styczyński et al. at work about the importance of proprioception disturbances to the locomotor system, following other authors define it as: a specialized sensory function including feeling of movement (kinaesthesia) and the feeling of joint positions [35]. Proprioceptive feeling occurs in both the conscious and unconscious human nervous system, mainly composed of signals sent to the central nervous system by mechanoreceptors, which are in joint capsules, ligaments, muscles, tendons and skin [12,30]. These receptors are sensitive to various forms of mechanical deformation such as tension, compression, and load size. If the ability to gather this information is somehow impaired it weakens not only the ability to control the movement in the joint, but it can affect the entire human posture, increasing its tilt eg. when standing [3.10].

According to many researchers, long-lasting neck pain interferes with afferent nerve conduction perpetuating abnormal muscle tension within the back of the head, neck and shoulder girdle, which adversely affects the feeling of proprioception of the cervical spine. Solid, abnormal muscle tension promotes ischemia and releases inflammatory mediators by reinforcing the sensitization of pain [2.10]. Research Kristjansson et al. Have shown that people complaining of neck pain, especially those of whiplash trauma are feeling decreased position of the head [17,18]. Interestingly, the preliminary studies Lark et al. have shown that rugby players exposed to chronic overload resulting from sport, consequently accumulate microinjuries resulting in similar symptoms as patients after acute injuries of the cervical spine, for example whiplash type [19].

Has described the disorder, usually lead to abnormal head position and cervical spine relative to the rest of the body (usually excessive protraction). From the biomechanical point of view, this reduces the range of movement of the neck and adversely affects the opportunities to oppose the external forces, disrupting the muscle balance and weakening its stabilizing function [6.32]. The aim of a variety of therapeutic and rehabilitation programs is

to restore a motor control and the range of motion of the patient in a manner that teach to set it back in the neutral position, anatomically adapted to counteract the external factors affecting him [9]. The concept of Kinetic Control defines the neutral setting of the cervical spine, in addition to describing in detail the way in which the movement should be carried out, taking into account the function and activation of individual muscles. Following the guidelines of the said method it is assumed that:

- division led from the earlobe to the back affects the clavicle (when properly adjusted shoulder);
- Line drawn from the middle of the thoracic spine to the sacrum is back away from the back of the head about 1-2cm;
- Mastoid process of the temporal bone, acromion and ischium should be arranged in a vertical line [7].

Disorders of stability within the cervical spine may appear years before the onset of clinical symptoms, such as discs protrusions or radiologically confirmed signs of degeneration of the intervertebral disc, significantly hindering the functioning of the patient and potentially reducing the maximum capabilities of the athlete. From the point of view of physiotherapy practice, including diagnosis and early detection of functional dysfunction of proprioception, an important objective seems to be seeking equipment to assess proprioceptive control.

Today, there are several devices designed to give a fair assessment of deep sensation of the neck. Since the sense of proprioception largely depends on nerve conduction, accurate measurement of its quality is difficult and requires using of sophisticated diagnostic equipment impractical in terms of the individual therapeutic practice^[13]. A useful test to evaluate the deep sensation of the patient, as well as the effects of the treatment of the cervical spine can be a test of relocation of the head to a neutral setting. This method allows to assess the ability of an individual to return to a neutral setting head or the possibility of positioning it in the desired position by the therapist [40].

PURPOSE OF WORK

The aim of this article is to present the possibility of using Laser Tracker - a simple, compact device intended for research and training in the deep sensation of the head and neck.

LASER TRACKER

The kit consists of a battery-powered laser diode fixed to the rubber band targeted at the head of the patient (Fig. 1), diagnostic mat (Fig. 2) and two exercise mats measuring 24 "x24" (Fig. 3, Fig. 4). Undoubted advantages are small size of the device, no need to use a computer and special software and the ease and speed of use. The test has a good reliability and reproducibility embodiment [1,20,26].

To perform the test it is necessary to have a stable chair with a backrest, a mat with a shield and a laser tracker. During the test, the patient sits in front of the shield-mat away from its center point about 90cm, with a mounted band using laser light point on his head. Note the position of the feet flat and stable backrest of the tested person. Adjusting the angle of incidence of the laser beam must be done with eyes closed and under relaxed, neutral position of the tested subject. The laser device should be located as close to the eye over the root of the nose as possible (Fig. 5).

The room where the test is performed should be spacious, not too brightly lit, allowing clear vision of the laser beam falling on the shield. It should be ensured that in the area were the least distractors (radio, noise, conversation, variable lighting), which could hinder concentration on the task. Before starting the test, it is sure that the subject does not feel tired or did not perform activities that could affect muscle fatigue. The research shows that muscle fatigue adversely affects the accuracy of the test procedure [24.27].

After calibration of the device, the tested person is verbally instructed regarding the steps that will be performed. Diagnosis undergo four movements: rotation to the right, rotation to the left, flexion and extension, performed with the eyes closed. Each movement should be performed natural, as far as possible, but not severe extending the range of motion. The task of the tested person is to return to neutral (initial) settings of the head (Fig. 6, Fig. 7). It is acceptable eye opening between attempts. According to the research performance of 6 to 10 repetitions of each movement gives measurable effects^[11.36]. It is advisable that before testing a particular movement to carry out an "empty" test, so the subject will be able to coordinate and practice the task. To mark the result on the dial can be used washable markers or colored plasticine. Care should be taken that each mark was represented in a different way (e.g.. A different pattern or color of the tag). Also noted are the pace and quality of the carried movement. Duigally recommends that during the test examined should be encouraged to perform movements at a faster pace. The first two inner circles marked red restrict the permissible error of the positional movement.

The natural desire of participants to achieve a result as close as possible to the center of the target often results in an inadvertently self-correcting the position of the head, and thus the laser. For this reason, after completing a movement attempt it is suggested to ask the participant to hold on with the opening of the eyes until the mark on a mat is given. A positive test result is considered to reproduce the patient's symptoms or the situation in which most of the test samples are outside the allowable positional error.

Other mats attached to the kit are used to improve proprioception of the head in patients with irregularities. They are interesting, engaging form of exercises for the cervical spine. The purpose of the test can be a displacement of the head from point A to point B at first with your eyes open, and then repeat the test without checking eyesight. An additional difficulty may constitute sitting the participant on an unstable surface, eg. gym ball. Another interesting exercise for improving the stability of the head and neck in a neutral position to a tested person is to command to move the eyes or vision for the leadership of a moving target with attention paid to the head remained motionless. During this exercise, regardless of the viewing direction, the laser light should be in the designated area. Research indicates that people suffering from "overload" neck pain and acute and chronic type injuries "*whiplash*" worse cope with kinesthetic test head [17,18,34,38]. Preliminary studies Pinsault et al. have shown that the possible disorders within the vestibular-cochlear do not have a significant effect on the test results, but this is still of interest to researchers [28].

Classes using the laser tracker in addition to impact directly on the function of the cervical visibly indicate a test errors which gives compensations, which are used during the execution of movements (for example. craning his chin, the laser beam is moved upwardly, too much retraction - the laser beam moves in down). In addition, its use can be found in the sports in which cervical spine is exposed to external injuries. After prior calibration, matched individually to the athlete, exercise with its use may constitute a starting point for the study of basic items used in the sport (eg. guard in boxing, the seating positions in sports racing). Testing the relocation of the head, may also be a diagnostic test to improve the overall proprioception, because Beinert and Taub showed that the general equivalent training improves proprioception of the cervical spine, regardless of exercises aimed directly at him [3].

Naturally age is deteriorating quality of proprioception. Older people's deep sensation is worse compared to young participants [1,39,41]. This is due to dehydration of the discs, intervertebral space narrowing and deepening of the physiological curvature of the spine. Shoulders forward ejecting and setting head in persistent protraction is body's natural

tendency to seek equilibrium. Such an attitude not only interferes with the working conditions of anatomical joints of the spine and shoulder girdle, but researches of Yong et al. has shown that they adversely affect the participant's result of relocation of the head to the neutral position [42,43].

SUMMARY

Laser Tracker is an interesting device to evaluate the individual's head proprioception. The relocation test carried out with its use provide a reliable assessment of the proprioception of the cervical spine. Use of the device is not limited only to the diagnosis. Using a variety of boards can prepare sets of training, that can engage people of all ages to exercise, while giving feedback on how to carry the move [14]. Large application can be found not only in working with patients suffering from cervical pain, but also in people who have problems with balance or as a form of training in postoperative rehabilitation, or in the elderly [29]. This training can be successfully used also in professional athletes exposed to mechanical overload and whiplash injuries as part of post-traumatic rehabilitation of the cervical spine, or in the form of prevention. In the light of the role that fulfill the cervical posture for the entire body, and the fact that proper proprioception is the main pillar of prevention of injuries and overload control determines the correct neuromuscular therapy should help with visual feedback, which gives the opportunity to the Laser Tracker. In practice, the office seems to have a therapeutic effect on the invaluable role and unlimited possibilities of further use.



Fig. 1. The Laser Tracker.

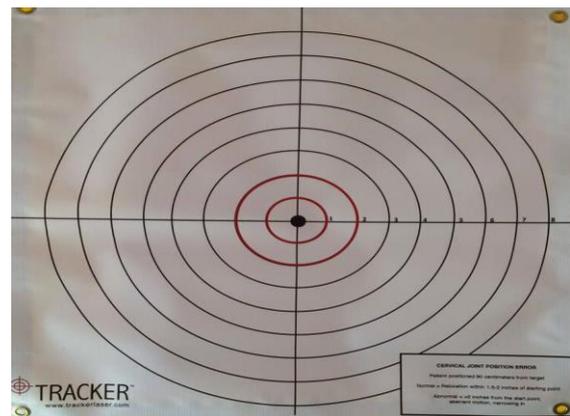


Fig. 2. Diagnostic mat with a shield. The two inner circles, marked in red define permissible error repositioning.

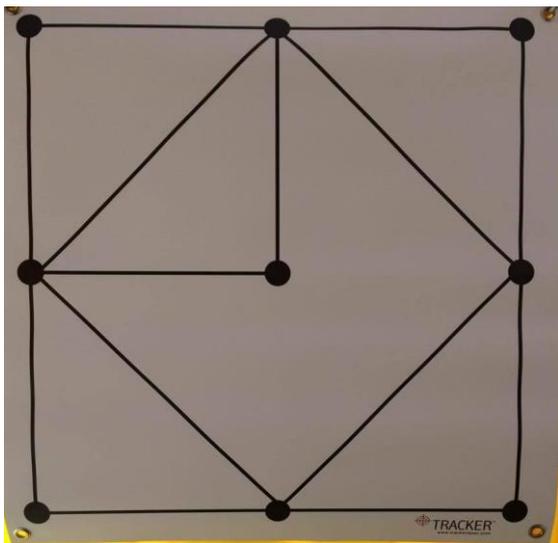


Fig. 3. Mat Learner I.

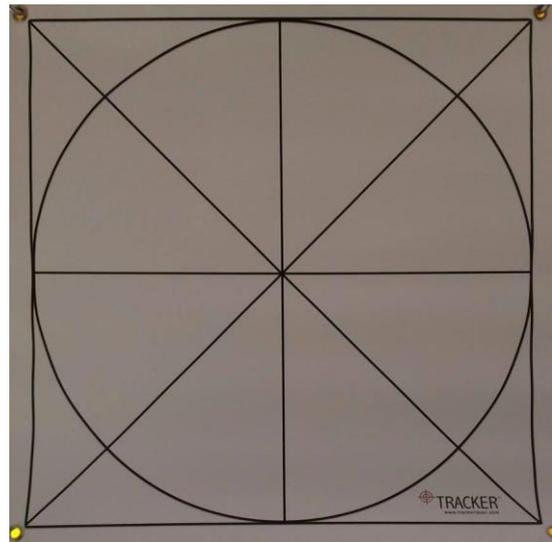


Fig. 4. The mat, practice II. It is located on the back of the previous one.



Fig. 5. Starting position for the test. The participant takes the free position, with feet flat and set back in a chair. In this position the settings of the laser diode are adjusted so that the beam fell on the center of the target.



Fig. 6. The participant closes eyes and rotates the head then returns to the starting position. Between attempts it is allowed to open eyes.



Fig. 7. End position of the movement can be marked on the board, for example with plastelin or washable marker

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