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Review Article

Orthopaedics Section

Methods of Postural Assessment Used for Sports Persons

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ABSTRACT

Occurrence of postural defects has become very common now-a-days not only in general population but also in sports persons. There are various methods which can be used to assess these postural defects. These methods have evolved over a period of many years. This paper is first of its kind to summarize the methods of postural assessment which have been used and which can be used for evaluation of postural abnormalities in sports persons such as the visual observation, plumbline, goniometry, photographic, radiographic, photogrammetric, flexiruler, electromagnetic tracking device etc. We recommend more and more postural evaluation studies to be done in future based on the photogrammetric method.

Keywords: Posture, Photogrammetry, Injury

INTRODUCTION

Assessment of posture forms the very basis of physiotherapy assessment. It helps in identifying the defects in body, which lead to various musculoskeletal problems. Postural assessment is an important tool which can be used to assess the reasons behind various injuries in sports persons, since repetitive loading of body caused by sports activities leads to certain postural alterations, which can ultimately cause pain and injury. A variety of postural assessment methods have been in use. Some are conventional, while some are latest and few are those which got modified into latest form from conventional forms i.e. these evolved into better and convenient methods. Only conventional methods were used in the past when advanced methods were not available. These have now been superseded by newer methods. However, the older ones are still used when the option of availability of advanced methods is not there. Following are some of the conventional methods.

Visual observation method

It is the commonest method which is used to assess posture in clinical practice. The one and only advantage of this method is that it does not require any equipment. With this method, quantitative data cannot be obtained. Thus, minor postural alterations cannot be detected. Also, it has been reported to have a poor interrater agreement [1]. All these limitations discourage the use of this method for scientific research purposes. A recent study [2] was done, based on visual observation method. The following variables were assessed: head position in frontal plane, neck position in frontal plane, side head position, side neck position, position of shoulders in frontal plane, position of shoulders in sagittal plane, thorax aspect, knees aspect, shoulder blades position, scapulae alatae, lordosis, kyphosis, scoliosis, lorenz's triangle, spina iliaca, anterior superior position and flat feet. If a postural problem was present markedly, it was reported; otherwise, it was marked as "0". Whenever non-agreements occurred between the check sheets of two kinesitherapists, a discussion was made, so as to reach an agreement and whenever this discussion failed, a third expert was asked to evaluate the posture of that subject. The decision of the majority was finally accepted.

Plumbline method

Use of plumbline for the evaluation of posture, along with a postural grid, too is very common, owing to its low cost and simplicity. Posture is evaluated in accordance with the guidelines which are given by Kendall, in form of ideal plumb line alignment for side and back views. Disadvantage associated with this method was that this method too could not be used to produce quantifiable data [3,4].

Plumbline method [5] was used to evaluate the postures of 14 male and 12 female university sports players who were aged 18-28 years. White adhesive labels were used to mark greater trochanter, posterior superior iliac spine, lateral femoral epicondyle, centre of the shoulder joint and anterior superior iliac spine, prior to postural assessment. Subjects stood in front of a posture grid which was placed behind the plumbline. Subjects were asked to walk on the spot for ten paces and to then stop. Lumbar lordosis curvature, pelvic alignment and hip joint axis were recorded to categorize the posture into lordotic, swayback, flatback or optimal type. Swayback posture was found to be the most prevalent amongst the 26 subjects and the flatback posture had the least prevalence. The researchers found a close association between pain and lordotic posture. Conversely, no pain was reported by 84 % of the players who were classified as having an optimal posture.

Goniometry

Goniometers are used in physiotherapy practice, not only to measure joint ROM, but, also for the assessment of posture [6]. Measurement of postural angles, such as neck inclination angle (Craniovertebral angle) and cranial rotation angle (sagittal head tilt) by using manual goniometry has been reported in the literature [7]. Manual goniometry possesses good to excellent reliability and thus, it is used as a reference for comparison with newer methods of postural assessment [6]. But, one study which was conducted on fifteen non-patient subjects reported that this method had poor interrater reliability for measuring angular variables. This was attributed to the difficulty in maintaining the arm of the goniometer parallel with the horizontal. The ICC measures were found out to be R=0.68 and R=0.34 for cervical rotation angle and neck inclination angle, respectively. The authors had suggested about developing a more reliable method in future for measurement of these angles [7].

Next came the photographic and digitization method that led to modernization of postural assessment, since it provided the physiotherapists with quantifiable and reproducible data, along with advantages such as simplicity and convenience, that made it very popular.

Photographic and digitization method

Photographic and digitization procedure has been in use since a long time. It has been compared with the radiographic method for postural evaluation. Its reliability too has been tested. Following are some of the research studies which were conducted in the past by using this method:

Kilinç et al., [8] conducted a study on 40 male children to find out the effects of one-sided and double-sided basketball training drills on the postures of these children. Two groups were made, with each group consisting of 20 children. One-sided dribbling group had children with mean age of 11.1±0.65 years and double-sided dribbling group had children with mean age of 11.7±0.81 years. The children were photographed in anterior and lateral views by using a digital camera which was kept on a tripod, in such a way that the distance between the camera and the subject was 150 cms. and the vertical distance between the ground and camera was 90 cms. The images which were thus obtained were analyzed by using the "Posture Analysis" software. The children were trained for 10 weeks (2.5 months) in such a way that there were 20 rest days and 47 training days. The duration of each session was 1.5 hours. Drills were performed by using the dominant hand only by the children who belonged to one-sided dribbling group and these drills were performed on both the sides by the children who belonged to double-sided dribbling group. On the last day of training i.e. on the 67th day, post-test images of the children were again captured by using the same procedure as that which was used for the pre-test images. The results revealed significant differences in the posttest values of shoulder asymmetry, chest asymmetry and dorsal angle between the two groups. The posttest values of the dorsal angle were found out to be 154.9±4.4º and 154.2±4.9º for the single-sided and double-sided dribbling groups, respectively. Similarly, the post test values of the chest asymmetry and shoulder asymmetry were found out to be 1.33±0.3º and 0.95±0.3º and 1.49±0.3º and 0.96±0.2º for the former and latter groups respectively. The authors advocated the use of double-sided dribbling exercises during the training, instead of only single-sided exercises, since the latter were found to cause shoulder and chest asymmetries.

Scientific evidence for postural evaluation of gymnasts is noteworthy. In a study which was conducted by Radaš and Bobic [2], 17 postural variables were measured in rhythmic gymnasts and non-trainees and a greater frequency of a poor kyphotic posture in non-trainees and a poor scoliotic posture in gymnasts were reported. Guimarães et al., [9] had selected 84 female students who were aged 8-12 years, to differentiate between the posture of 38 Olympic gymnasts and 46 non-athlete children, both qualitatively and quantitatively. Subjects were photographed from front, back and right sides with the camera being placed 2.56 metres away from a square board. The subjects stood as close as possible to this board in such a way that there was no contact between subject and board. Prior to taking the photographs, certain anatomical landmarks were marked by using adhesive tags. The photographs which were thus obtained were analyzed by using Corel Draw, v.11.0 software. The results revealed that the gymnasts possessed increased lumbar hyperlordosis and a better aligned lower limb (a decreased pelvic asymmetry, knee valgus and medial rotation of femur). Also, anterior pelvic tilt was found to be more prevalent in this group.

When 28 male university players were assessed for posture, it was found that the throwing arm always showed presence of dropped shoulder in the participants. Out of 28 subjects, 9 had dropped shoulders. In this study, camera was used to click photographs of the subjects from anterior, posterior and lateral views, while the subjects stood against a postural grid. No correlation could be found out between shoulder posture and performance of the player. The researchers recommended future studies which should be based on larger populations, so as to check whether any correlation existed between shoulder posture and performance. They had also suggested evaluating the postures of players who practise other sports [10].

Total 2,270 subjects were recruited by Wojtys et al., so as to measure their thoracic and lumbar angles. A total of eight groups were there, namely: control group, track, volleyball, hockey, wrestling, football, swimming and gymnastics. Subjects were photographed by using a camera after placing surface markers at T1, T10, L2 and S1 levels. A significant correlation was depicted between the total number of training hours per year and the degree of thoracic curvature and lumbar curvature, i.e. more the number of training hours, higher were the values for thoracic kyphosis and lumbar lordosis. Among all the groups of sports, gymnastics group demonstrated the highest thoracic angle value (42.4±13.4 degrees), lumbar angle value (52.1±16.7 degrees) and training experience (439 hours per year). Similarly, track group which had the least training experience (198 hours per year) yielded the lowest values; 29.5± 10.1 degrees and 33.5±17.0 degrees for thoracic angle and lumbar angle, respectively. The results revealed that the non-athletic population had shown lesser values for thoracic and lumbar angles than the athletic population. Mean values of the sagittal curvatures of the non-athletic group were, thoracic angle= 16.1±10.4 degrees and lumbar angle= 17.6±15.6 degrees. Also, significant differences were found between the control group and each of the sport. This finding suggested that playing sports placed an influence on the postures of the players [11].

Postures of female volleyball players (n=42) were compared with the postures of untrained girls (n=43) who were aged 13-16 years. The results signified that volleyball players had greater kyphosis and lesser lordosis than their untrained counterparts. Greater symmetries were found in the volleyball players for shoulder and pelvic positions as compared to those seen in untrained girls. Also, the former had more asymmetrical shoulder blades and waist triangles than the latter [12].

Radiographic method

The "gold standard" method that exists as of now is the radiographic method and it is one of the latest methods. But its cost and risk of exposure towards harmful radiations promotes the use of non-invasive methods for the measurement of postural variables [8,13].

In a study which was done by Neikerk et al., two postural tools were used. LODOX (low dose radiograph) was used to obtain radiographs and PPAM (photographic posture analysis method) was used to take photographs of the subjects in the sitting position at a computer workstation. A total of 39 subjects were there. Both of the measurement tools captured images of the subjects from head to T8 level, with the camera being placed two metres away from the chair, on a tripod. Retroreflective markers were placed at 6 anatomical landmarks. Intellect 1.1.4 software and an additional software (DVT Reader) were used to digitize the markers. Trigonometric formulae were used to calculate the various angles of the upper body. The values of five postural angles, which were obtained by using the two methods were compared and a strong correlation was found between them, except for one angle (protraction/retraction angle). Authors concluded that apart from the existing 'gold standard' method i.e. the radiographic method, photographs could be thought to be as an alternative 'gold standard' for evaluation of sitting posture [13].

Photogrammetric method

Off-late, photogrammetric method has come into existence and its use as a method for postural evaluation is indisputable. This method seems to have evolved from the photographic and digitization method. In this method, photographs of the subjects

are taken in frontal or sagittal plane with a camera which is mounted on a leveled tripod stand, which is placed at some distance from the subjects. This distance varies amongst various researches. The photographs which are thus obtained are transferred to a computer system. They are used to calculate postural angles with the help of some software which has been installed in the computer system. The type of software too varies from research to research. Angles are then drawn between the markers by drawing horizontal and/or vertical lines. With the use of this method, quantifiable and reliable data can be obtained. Its use in measuring head posture, shoulder posture, cervical lordosis, thoracic kyphosis, lumbar lordosis, lower limb posture and pelvic tilt has been reported in the literature [1,6,14]. This method was compared with the visual method, goniometry and radiography [1,6]. Reliability of this method too was tested. Various postural evaluation studies which had been conducted by using this method are.

Photogrammetry versus radiography

Upon comparison of postural angles which were obtained from photographic images with the angles which were obtained from radiographic images, craniovertebral and cervical inclination angles were found out to be valid measurements for the assessment of craniocervical posture [15].

Reliability of photogrammetric method

Photogrammetry has been reported to have a good to excellent interrater reliability. The ICC values which were obtained for 33 postural variables were between 0.84 and 0.99 [16]. The digital camera that was used in this study was placed at a distance of 3 metres from the subject and at a height of 90 cms from the ground, on a tripod, so that all the anatomical landmarks, starting from glabella till the point between head of second and third metatarsals, were visible in the photographs. SAPO software was then used to analyze the various postural variables.

In a recent study [17] done by Souza et al., digital camera mounted on a tripod was placed 3 metres from the subject at a height which corresponded with approximately half the subject's height. Whole body images of the subject were obtained, with the camera being placed anterior, posterior and lateral with respect to the subject. The researchers had used SAPO posture assessment software (v.0.68) in their study. Interexaminer and intraexaminer reliabilities were examined after measuring 20 angles (A1 to A20) by three examiners. The ICC measures for trunk angle (A13) and hip angle (A14) were found out to be 0.623 and 0.568, respectively. The level of reliability of these two angles was thus classified as not acceptable. The ICC values for leg/right hindfoot angle and leg/left hindfoot angle were 0.743 and 0.860, respectively. The former's level of reliability was classified as acceptable and the latter's as very good. The interrater reliability for rest of the angles was classified as excellent, since the ICC values for these were greater than 0.90. Four out of twenty angles yielded non-repeatable intrarater values. The authors of this study had concluded that most of the angular measurements which were proposed by SAPO protocol were reliable for measuring various postural asymmetries. They also advised that caution should be excised when non-acceptable and non-reliable angles were used for the quantification of posture. ICC values of 0.89-0.99 for inter-rater reliability were obtained in another research study which was done for the evaluation of craniocervical posture [15]. Intra-rater reliability of this method too was found to be excellent (ICC= 0.98-0.99) [15], which suggested that repeated measurements made by the same rater had very well accorded with each other.

Miscellaneous

Variety of other methods exist, such as "posturometer", which is an electronic measuring-diagnostic device, "flexiruler", which can be moulded according to the curvatures of the spine, Moiré topography, which creates certain contour lines on the body and electromagnetic tracking devices for 3-dimensional analysis of posture. However, 3-dimensional methods are costly and not ubiquitous.

Greenfield et al., had used a flexiruler to measure the midthoracic curvature. The flexiruler, after being placed on the spine, such that its tip was at T2 vertebral spinous process and it was marked at T12 level, was placed on a paper, so as to trace its curve. The height (h) and length (l) of the curve were measured by using a ruler and midthoracic curvature was found out by using the formula: ø= 4 X [arctan (2X h/l)]. These authors had even reported that the ICC values for intrarater reliability and interrater reliability were 0.84 and 0.70, respectively. A flexiruler can only be used to measure the spinal curvatures [18].

Lichota et al., [19] examined the postures of 46 athletes who were aged 20-24 years, who belonged to different sports groups. A total of four groups were identified, namely: handball (n=16), athletics (n=9), taekwondo (n=5) and volleyball (n=13). "Poturometer-S" was employed to measure the various angles of the spine. Lumbar lordosis was found to be less common than thoracic kyphosis amongst all 43 subjects. The highest values for α angle, β angle and γ angle were reported in volleyball (15.2°), athletics (12.6°) and taekwondo (14.0°) groups, respectively. The lowest values for α angle, β angle and γ angle were observed in athletics (12.4°), handball (8.8°) and handball (8.0°) groups, respectively. Authors contended that posture was affected by sports training and that the type of sport influenced the type of posture. A posturometer is not readily available and it requires a thorough understanding before it can be used. Scapular positions of competitive tennis players (n=13), competitive volleyball players (n=15) and collegiate baseball pitchers (n=15) [20] were assessed by using an electromagnetic tracking device. All of the subjects were healthy males. Receivers were attached onto the C7 spinous process, right and left acromion processes and right and left midshaft of posterior humerus by using double-sided adhesive disks. The stylus also had one receiver which was attached to it. Digitization acted as a means for estimating scapular position by using the local coordinates. Subjects were asked to perform shoulder elevation, bilaterally, in the scapular plane, ten times in a continuous fashion. Scapular posture was assessed when the arms rested at the sides. Scapulae of dominant sides were found to be more anteriorly tilted and internally rotated than those of the non dominant sides. Tennis players also demonstrated increased protraction at the dominant side. This supports the concept that different types of sports influence the posture in different ways. This study also highlighted the importance of doing posture evaluations before and after injury.

Moiré topography [21] was used in a research study which was done by Uetake et al., 380 female subjects who were aged 21.8±4.0 years were divided into eleven groups, namely: soccer, swimming, rugby, kendo, sprinting, throwing, sailing, jumping, body building, distance running and non-athletes. Sports players possessed an experience of 4 to 17 years in their respective fields. Anatomical landmarks that were marked prior to taking the photographs were a point of cervical prominence and the point where a line which joined the highest points of the iliac crests intersected the vertebral column. Moire apparatus consisted of a light, a camera and a grid. 3mm contour lines were generated by this apparatus. This method has been reported to be non-invasive, safe and non-contacting. S-shape of the curvature which was obtained with the use of this method, comprised of lumbar and thoracic curves. Deep S-shaped curvatures were found in distance runners, sprinters, throwers, kendo participants and jumpers, while shallow curvatures were found in non-athletes, bodybuilders, swimmers and sailors.

DISCUSSION

The commonest method which is used to assess posture is the visual observation method, since it does not require any equipment. With this method, quantitative data cannot be obtained, minor postural alterations cannot be detected and it possesses a poor interrater agreement. All these limitations discourage the use of this method for scientific research purposes. Use of a plumbline and a postural grid for the evaluation of posture too, is very common, owing to its low cost and simplicity. This method too cannot be used to produce quantifiable data. Goniometers are also used for the assessment of posture, despite difficulty in maintaining the arm of the goniometer parallel with the horizontal. The "gold standard" method that exists as of now is the radiographic method. But its cost and risk of exposure towards harmful radiations promote the use of non-invasive methods for the measurement of postural variables. Off-late, photogrammetric method has come into existence, which is a further advancement of photographic method and its use as a method for postural evaluation is indisputable. This method has been compared with the visual method, goniometry and radiography. Reliability of this method too has been tested. Variety of other methods exist, such as "posturometer", "flexiruler", Moiré topography and electromagnetic tracking devices for 3-dimensional analysis of posture. However, 3-dimensional methods are costly and not ubiquitous.

CONCLUSION

Photogrammetric and radiographic methods seem to be the most reliable methods which can be used for obtaining values which are related to posture. However, the latter has its own disadvantage of exposing the subjects to harmful radiations. Thus, the use of photogrammetric method is recommended for future studies which will focus on posture evaluation.

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