ANALYSIS OF TRUNK MOVEMENT IN PLAYING GOLF

J.C.M. Derksen, M.P.J.M. van Riel and C.J. Snijders

Department of Biomedical Physics and Technology
Faculty of Medicine and allied health sciences
Erasmus University Rotterdam, The Netherlands

INTRODUCTION

In spite of the recognition of the large contribution of back complaints to the number of golf injuries (McCarrol, 1982), very little is known about the movement of the trunk during the golf swing and the resulting load on the lumbar spine. In the field of golf medicine, studies are generally based on epidemiologic or rather subjective data. In this paper a new method for measurement of trunk movements is introduced, which could possibly be an important contribution to the existing methods. The objective of this pilot study is to provide a quantitative description of trunk postures and movements in five different types of golf swings.

METHOD

The method used for measuring the postures and movements of the trunk is the Portable Posture Registration Set (PPRS), which has been developed at our department (Snijders et al., 1987). With this method inclination and rotation of the trunk can be measured, but also the curvature of the spine in two directions: the sagittal plane (anteflexion and retroflexion) and the frontal plane (lateroflexion). Small sensors are attached to the skin of the back by tape and connected to a small four-channel modified tape recorder (Medilog 4-24, Oxford Medical Systems).

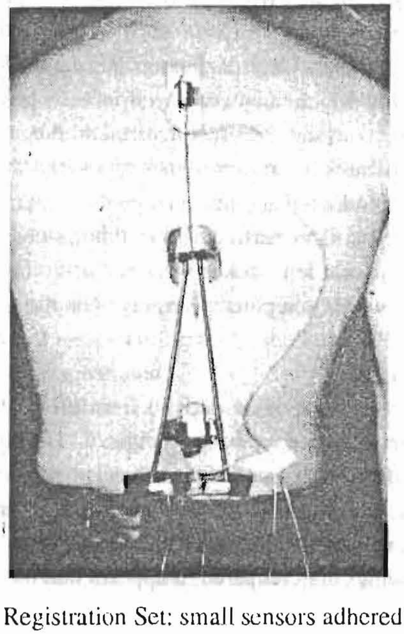

Fig. 1.: The Portable Posture Registration Set: small sensors adhered to the back of the subject.

The subjects carry the recorder on a belt. The photo (figure 1) shows the sensors and their positions on the back of a subject. Due to their small sizes and weights, neither the sensors nor the recorder cause any hindrance to the subjects while playing golf. Registrations are continuous, with a sample frequency of 25 Hz, and can be made during a long period of up to 24 hours.

The inclination of the trunk is the position of the trunk as a whole in relation to the vertical. This angle is measured by an inclinometer, based upon a pendulum potentiometer. It is placed on the skin at the level of L2/L3. The inclination of this part of the spine is assumed to be representative of the position of the trunk as a whole. The measurement error of the device is below 1 degree over a range of 100 degrees. The rotation of the shoulders in relation to the pelvis is also measured by a potentiometer. The housing of the potentiometer and that of the end of the shaft are attached to the skin at the levels of T2 and T10 respectively. In this region about 68% of the total thoraco-lumbar rotation occurs (White, 1987). Therefore, the rotations measured by the torsionmeter are multiplied by 1.47, interpolating to the whole thoraco-lumbar spine. Because the skin stretches during flexion, translation of the driving shaft with respect to the housing is permitted. Changes in the curvature of the spine as a result of ante-, retro- or lateroflexion are recorded by measuring the change in length of the skin between L5 and T8. The device for measuring these changes consists of two helical springs, which are connected to a force-transducer. Each spring is fastened at one side of the spine (fig.1). Change of curvature of the spine induces a change of length of the springs, which results in a change of force that is recorded by the transducer. The mean of both lengthmeters is a measure for sagittal flexion, while the difference between them is a measure for lateroflexion. The accuracy of this device is approximately 3 to 4% of the full range of 11 cm. Inclination and rotation are given in degrees and sagittal- and lateroflexion in millimetres change of length, all with respect to the upright position which is determined at the individual calibration.

The analogue electrical signals from the sensors are digitized and fed into a computer (PDP11/73). A computer programme converts each signal into three histograms, using 2° (inclination and rotation) and 2 mm (sagittal flexion and lateroflexion) classes. In the duration time histogram the time during which subjects stayed in each posture-interval is given as a percentage. From this histogram some statistics (percentiles, modus, range) are calculated, which can be used to characterize the postures in different types of swings. In the other histograms the number of times every position was adopted and the average duration of each posture are given.

Four male right-handed golfers participated in this (pilot) study, with handicaps +1, 3, 11 and 36. On a driving range at least ten strokes were performed of a 6 iron-shot, a drive, a pitch and a chip successively. Afterwards, ten putts were played on the green.

RESULTS AND DISCUSSION

From the statistics which have been derived from the three histograms of every subject, the averages and standard deviations have been calculated. The standard deviations proved to be quite large, which is due to the fact that only four subjects have been measured, who do not form a homogenuous group either. Therefore only the most evident differences will be discussed. For a detailed movement analysis, measurement of more subjects will be needed.

If the five types of swings are compared, it appears that the shorter the stroke, the more the subjects bend over: on average the inclination most frequently adopted (modus) increases from

40° in playing a 6-iron to 45° in putting. This results in large percentages of more than 20° inclination of the trunk (60-80%), as shown in figure 2. In this figure the sequence mentioned (the shorter the swing, the more inclination) is clearly visible. The drive does not fit in because of the excessive bending while positioning the ball on the tee.

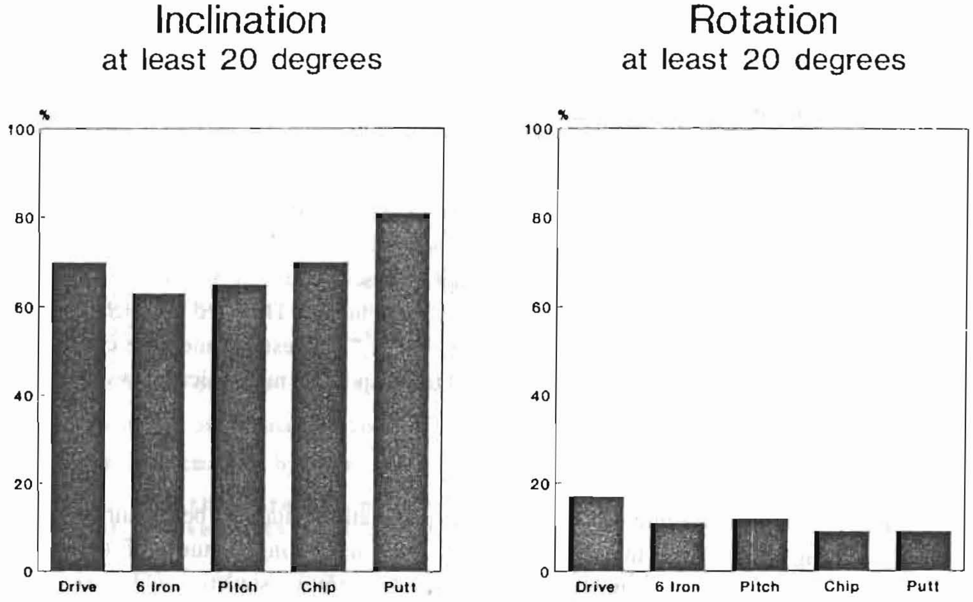

Fig. 2: The percentages of time measured in which inclinations (left) and rotations (right) over 20 degrees have been recorded.

Comparison with a standard used in occupational health (OWAS-method, Karhu, 1977), reveals that playing golf poses a considerable load on the low back, especially in playing drives and in putting. According to the OWAS-standard, the need for taking measures is present if the percentage of inclination over 20° during the day exceeds 30%. If the percentage exceeds 80%, corrective measures should be taken as soon as possible! The combination of inclination and rotation, both over 20°, is assessed as extremely harmful: measures are already advised if at least 5% of the inclination is accompanied by rotation. For rotation alone, measures should be taken if the percentage exceeds 20%, which is not the case. The percentages given should not be seen as strict borders but if one looks at figure 2 remembering them, the large contribution of inclination to the load on the lower back is clearly demonstrated.

The contribution of rotation however, seems to be smaller than is generally thought. The large amount of rotation of almost 45 degrees to both sides that Von Flock (1989) mentioned could not be confirmed in this study; excessive rotations like that only occurred seldomly. There is little difference in the amount of rotation in drives, 6-iron shots and pitches, all having a range of about 41° and maxima of about 28° to the left and 15° to the right. The chip shows a little less rotation, but much more evident is the difference with the putt, which shows a range of only 20 degrees.

Except in putting, rotation to the left (p5) is larger than to the right (p95), causing asymmetrical loading of the back. The differences are largest during the 6-iron shots and pitches: 15 and 13 degrees respectively. Another factor contributing to the asymmetrical loading of the back is lateroflexion. The ratio between maximum lateroflexion to the left and to the right varies from 2 (putt) to 8 (6 iron). This is probably also a result of the starting position, with the right hand below the left hand. Bending to the right decreases as the strokes become shorter.

In every respect, the putt is an exceptional swing with clearly more inclination and sagittal flexion but less rotation and lateroflexion compared to the other swings. The number of entries as well as the average duration time provide an impression of the dynamics of the swings. The longest average durations in all movements are seen in putting, which shows that this is the most static swing.

From the signals a lot of other data could be calculated, like angular changes, velocities and accelerations. Such data will be needed if one wants to look at inter-individual differences and their possible relation to back pain. In that kind of research proper selection of subjects is highly important and the sample frequency should be much higher. The need for such research in relation to back pain is stated by Steingard (in: Duda, 1987): "The best treatment we can give is to study the biomechanics of a patient's golf swing and try to spot any mechanical flaws that may be causing injury."

CONCLUSIONS

With the Portable Posture Registration Set quantitative data can be acquired on trunk movements during golfswings. In this pilot study some interesting features of the different golfswings have been revealed with the help of simple descriptive statistics. Discussion of the most striking differences in the average characteristics of the five types of swings studied have provided more insight in the amount of load these swings cause on the lumbar spine. Though this method seems also promising for comparison of swings of individual golfers, a large number of properly selected subjects and a higher sample frequency will be required for this.

REFERENCES

- Duda M. (1987) Golf injuries: They really do happen. The Physician and Sportsmedicine 15, 190-196.
- Karhu O., Kansi P. and Kuorinka I. (1977) Correcting working postures in industry: a practical method for analysis. Applied Ergonomics, 8, 199-201.
- McCarrol J.R., Gioe T.J. (1982) Professional golfers and the price they pay. The Physician and Sportsmedicine 10, 64-70. - Snijders C.J., van Riel M.P.J.M., Nordin M. (1987) Continuous measurements of spine movements in normal working situations over periods of 8 hours or more. Ergonomics 30, 639-653.
- Von Flock K., Gradinger R., Opitz G., Hipp E. (1989) Medizinische Ratschläge für Golfspieler. Fortschritte der Medizin 107, 774-776.
- White A.A., Panjabi M.M. (1978) The basic kinematics of the human spine, a review of past and current knowledge. Spine 3, 12-20