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BARYCENTRE POSTUROGRAPHIC ANALYSIS IN THE PATIENTS WITH COXARTHROSIS

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ABSTRACT

The present study analyzes the projection of barycentre within the support polygon and the distribution of the body weight on the lower limbs, comparatively for two batches of subjects. For the batch A, the assessment was unique, while for the batch B, there was a preoperative assessment. This way, we will analyse the loading and straining degree at the level of preoperative hip joints, with a subsequent identical postoperative analysis for the study batch. In this sense, we have used the GPS400 stabilometric platform that through the pressure sensors tests both the repartition of the body weight on the lower limbs and analyses at the same time the oscillations that occur during the orthostatic position. The principle of the stabilometric method is to analyse the barycentre variations in the orthostatic position. Postural assessment has been accomplished with a view to diagnose the deviations of the mechanical loading charges at the level of hips, the efficiency of the surgical intervention and of the recovery programmes.

INTRODUCTION

In orthostatic position, the torso tends to bend forward because of the overall weight of the upper body, its common barycentre projecting on the ground before the vertical. The paravertebral muscles go against this falling tendency through their permanent contraction.

Besides this, pelvis plays an essential part in the balance of the human body. It makes the connection between the torso and the lower limbs, being situated at the intersection of the three planes. In fact, the point where the three planes intersect determines the barycentre of the body – generally at the level of the second sacral vertebra.

The more stable the balance of the human body is the closer the barycentre to the support basis and the closer the projection from the centre of the support polygon. For a stable balance, another essential element is the atmospheric pressure, "as passive stabilizing factor," as the Weber brothers demonstrated. Some conditions at the level of the coxofemoral joints may influence the distribution of the weight at the level of the lower limbs, as well as the projection of the barycentre in the support polygon.

In the vision of the specialists, in case of the normal walking, the total weight of the hip joint approximately equals 2½ compared to the body weight. As the body line approaches the centre of the hip joint, the force component due to the action of the abductor mechanism decreases, with a reduction corresponding to the force applied to the hip acetabulus, head, and bone.

According to ME Zeman, there are three tasks associated to the three critical cases within a walking cycle:

- support on the heel (I)
- total support on the limb (II)
- opening the toes (III)

PURPOSE

The present study analyzes the projection of barycentre within the support polygon and the distribution of the body weight on the lower limbs, comparatively for two batches of subjects.

METHODS

We have conducted a prospective study on a number of 21 healthy persons with no previous problems at the level of hip joints or lower limbs and 17 patients diagnosed with coxarthrosis with an indication for total hip arthroplasty, between January 2010 and December 2010. The study took place within the Orthopaedics Clinic of the Emergency Hospital “Prof. dr. D. Gerota”, Bucharest.

The study comprised two batches of subjects: batch A – 21 healthy persons with no previous problems at the level of hip joints or lower limbs; batch B – 17 patients diagnosed with coxarthrosis with an indication for total hip arthroplasty.

We present below the inclusion and exclusion criteria corresponding to the force applied to the hip acetabulus, head, and bone.

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for the two batches:

For the batch A, representing the witness batch, the subjects within the study had to meet the following requirements:
1. adults over 20 years old;
2. with no pathological conditions at the level of the coxofemoral joints and of the lower limbs;
3. with no balance disorders due to neurological or vestibular conditions.

For the batch B, representing the study batch, the subjects within the study had to meet the following criteria:
1. adults over 20 years old;
2. patients diagnosed with coxarthrosis, with the total hip arthroplasty as a therapeutic indication;
3. with no associated/important conditions at the level of the lower limb joints, except for the coxofemoral joints;
4. with no balance disorders due to neurological or vestibular conditions.

The present study analyzes the projection of the barycentre within the support polygon and the distribution of the body weight on the lower limbs comparatively for the two batches of subjects. For the batch A, the assessment was unique, while for the batch B, there was a preoperative assessment. This way, we will analyse the loading and straining degree at the level of preoperative hip joints, with a subsequent identical postoperative analysis for the study batch.

In this sense, we have used the GPS400 stabilometric platform that through the pressure sensors tests both the repartition of the body weight on the lower limbs and analyses, at the same time, the oscillations occurring during the orthostatic position.

The principle of the stabilometric method is to analyse the barycentre in the orthostatic position. The purpose of the postural assessment is to diagnose the deviations of the mechanical loading charges at the level of the hips, the efficiency of the surgery and of the recovery programmes.

The assessment had a predetermined 30-second duration, and the parameters determined under barycentre polygon displacement, in oscillographic form, by representing the frequency of oscillations and through mathematical processing of these data were the following:
- the number of recordings;
- frontal and sagittal mean deviations;
- length of the curve made by the barycentre in the testing time interval;
- the projection area of the barycentre for 90% of the trust interval (obtained by eliminating 10% of its extreme variations);
- average velocity of the barycentre variation;
- frequency of oscillations of the barycentre;
- frequency of Fourier fundamental harmonic oscillations – left-right and anterior-posterior.

Testing modality:
We have explained to all the patients the testing methods presented below:
- maintaining the orthostatic position, bipedal on the stabilometric platform, on the signs indicating the position of the lower limbs, without support, for both batches, A and B, as well as a second testing with support for the subjects of the batch B who use a stick to walk.
- the legs are parallel, slightly apart (around 5-10 cm between the heels), the body posture is as natural as possible, and the patients had to stand as still as they can.
- the testing last 30 seconds, before the muscles get tired, which may lead to intense postural and balance reactions or to oscillations that may produce important oscillations of the barycentre.
- the patient will go through a control testing at the beginning, in order to get used to and to understand it; the second testing being, in fact the real test.

Within the software, we will only analyze the values of frontal (left right) and sagittal deviations (anterior-posterior), as they make the subject of our study. The deviations from the normal values will be illustrated graphically on two axes indicating the deviation degree from the centre of the support polygon, and numerically in units. As for the sagittal ones, the anterior deviations will bear the “+” mark, and the posterior ones “–”. In the case of frontal deviations, the “+” sign will be attributed to numerical values representing the anterior deviations, and the “–” sign to the posterior ones.

We have processed and statistically analysed the data with the help of a statistical program, where we have analysed the standard deviations in the two planes for two batches of patients, as well as the correlation of the standard deviations.

RESULTS AND DISCUSSIONS

The research constituted a prospective study comprising a comparative analysis of the alterations in the loading of coxofemoral joints in normal situations and in the hip degenerative pathology. During the postural assessment, we have not noticed any important frontal alterations in the patients within the A witness batch, only the following:
- 7 mild scoliotic attitudes that, at the X-ray, did not show any important alterations at the level of the spine, Cobb angle < 10 degrees;
- 5 patients with no static vertebral alterations in the frontal plane;
- 6 patients with double-curve scoliosis;
- 2 patients with structural scoliosis between 10 and 20 degrees.

The deviations of the barycentre within the study batch A are not influenced by the vertebral static disorders; in this sense, we will present the projection deviations of the barycentre in frontal plane as follows:

For the seven patients with no important postural alterations in this plane, the deviations maintained in the interval 0.5-15.7 units towards right and in the interval -0.6 and -13.3 units for the deviations towards left.
- for the six patients with double-curve scoliosis, the oscillation interval occurred between 1-6.2 units toward the right and -1.9 and -7.5 units toward the left.
- for the two patients with structural scolioses: -7.5 and 4.6 units.

We have noticed that the biggest deviations did not occur in the case of the patients with structural scolioses, as they did occur regardless of the presence or absence of the conditions associated to vertebral static.

During the X-rays, at the level of the spine within the B batch, we have noticed alterations of vertebral static of the spine in frontal plane, antalgic scoliosis, but that do not exceed 20 degrees Cobb angle, in case of 13 patients.

Of the 17 patients of the study batch B, 9 presented disorders at the level of the left coxofemoral joint, and the other eight patients presented disorders of the right coxofemoral joint.

The data obtained show that the distribution of the barycentre in the case of the study patients directly correlates with the affected coxofemoral joint, as follows:
- nine patients with disorders of the left coxofemoral joint presented important deviations of the barycentre in frontal plane towards right;
- eight patients with disorders at the level coxofemoral joint...
presented significant deviations of the barycentre towards left.

These deviations may be the result of functional alterations at the level of the affected hip and of the intense painful reactions of this level. As a result of these expressions, the patient reflexively “helps” the altered hip by moving the body weight on the other side, at the same time moving the barycentre on the side of the healthy joint.

As a result of this action, a wrong static and dynamic stereotype appears, leading to the overcharge of the healthy lower limb through the supplementary joint loading, as well as to muscle hypotonias of the affected lower limb. It also leads to the alteration of the entire walk biomechanics by shortening the support duration on the affected lower limb. This way, the walk becomes painful, limp and the affected leg is not much used for support.

CONCLUSIONS

A rigorous and complete analysis at the level of hip articulation may bring additional important information in the case of the complex preoperative examination, thus contributing to the future therapeutic behaviour.

The analysis of the barycentre for the patients with indication of total hip arthroplasty is necessary during the preoperative phase to determine the degree of joint loading at the level of coxofemoral joints and the static, as well as the dynamic stereotype of the patient’s orthostatic position. This way, the future may bring complex recovery programmes in order to adjust the orthostatic or dynamic stereotype developed in time.

The presence of pain at the level of the affected hip leads, most of the times, to forming certain habits and a wrong static and dynamic stereotype, leading to the overcharge of the healthy lower limb. The asymmetric charges through a wrong positioning of the barycentre may lead to affecting the healthy joint or to accelerating the wearing out of the endoprosthesis.

The study of posture helps to a better understanding of the mechanism generating joint stress, pain, and discomfort, all of these finally leading to the alteration of the walking. Thus, we noticed a bigger deviation of the barycentre in frontal plane in the patients with pain at the level of the coxofemoral joint compared to the patients without such conditions.

The complex and correct functional re-education also has to take into account the postural re-education by analyzing the barycentre and by re-establishing a correct biomechanical balance at the level of the pelvis.

BIBLIOGRAPHY