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Original Article

The Accuracy of Socket Orientation using a Pelvic Fixation Device for Total Hip Arthroplasty with the Patient in the Lateral Decubitus Position in Comparison to the Vacuum Bag Fixation Method

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Abstract Background. In our department, a vacuum bag with two lateral boards used to be utilized in order to maintain patients in the lateral decubitus position during THA. However, we recently changed this modality to a three-point fixation device for the pelvis in order to accurately control the position of the acetabular socket. The purpose of this study was to retrospectively compare the orientation of the acetabular socket when THA was carried out using two different positioning methods.

Methods. Group 1 consisted of 66 hips that underwent THA in 1997 using a vacuum bag, which became rigid with suction. Group 2 consisted of 42 hips that were treated in 2000 using a three-point fixation device for the pelvis. This device was designed to be able to rigidly fix the bilateral anterior superior iliac spines and the sacrum. Before fixation with the device, the angle between the line aligning the anterior-superior iliac spines and the vertical plane in the lateral decubitus position was measured as the lateral pelvic tilt. The orientation of the fixed acetabular socket was evaluated based on postoperative radiographs.

Results. The average absolute value from 45 degrees in the abduction angle was significantly lower in group 2 than that in group 1 ($p < 0.01$). In 18% of the cases in group 1, the anteversion angle was over 30 degrees. In contrast, no such cases were observed in group 2. Postoperative dislocation occurred in six cases (9%) in group 1. In contrast, it only occurred in one case (2%) in group 2.

Conclusions. The positioning method using the pelvic fixation device enabled surgeons to more accurately control the position of the sockets during THA compared to using the vacuum bag. The positioning of the patient is therefore suggested to be an important first step in successfully performing THA procedures.

Introduction

One of the popular incisions for total hip

arthroplasty (THA) is a posterior or postero-lateral incision which requires that the patient be in the lateral decubitus position. It is important to maintain the position or orientation of pelvis as much as possible during THA in order to accurately control the position or orientation of the acetabular socket. A malposition of the acetabular socket may increase the occur-

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rence of impingement, reduce the range of motion, and increase the risk of a postoperative dislocation. In addition, it may also cause an increase in the long-term wear of the polyethylene liner^{1)~4)}.

In our department, a vacuum bag with two lateral boards used to be utilized in order to maintain the patients in the lateral decubitus position during THA. However, we recently changed this method to the use of three-point fixation device for the pelvis in order to more accurately control the position or orientation of the acetabular socket during THA. The purpose of this study was to retrospectively compare the orientation of the acetabular socket when THA was performed using two different positioning methods.

Materials and Methods

Two groups of the patients which had THA using each different positioning method were compared. Group 1 consisted of 66 hips of 63 patients who underwent THA from January to December 1997 using a vacuum bag (Magic Bed, Okada Izai, Tokyo, Japan). The pubis, sacrum, and

lumbar spine were covered with the vacuum bag, and then they were sandwiched with two side boards. Next, the bag was suctioned to firmly fix the patient body including the pelvis (Fig. 1). Group 2 consisted of 42 hips of 41 patients who underwent THA from January to December 2000 using a three-point fixation device for the pelvis (Universal Lateral Positioner, Innovative Medical Products Inc, USA). The device was designed to rigidly fix the bilateral anterior superior iliac spines and the sacrum (Fig. 2). Enough care was taken to accurately hold the pelvis which was positioned perpendicular to the operating table in the vertical plane of the patient body after checking the table to be parallel to the floor. Before fixation with this device, the angle between the line aligning the anterior-superior iliac spines and vertical plane in the lateral decubitus position was measured as the lateral pelvic tilt. When the socket was fixed to the acetabular fossa during THA using the manufacturer's guide apparatus, the lateral angle of the apparatus, which was one of the factors which were decided to set the abduc-

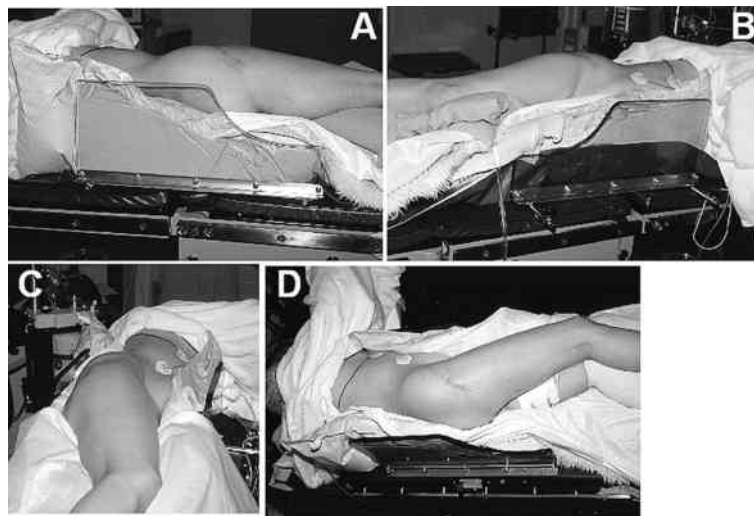


Fig. 1 Positioning with a vacuum bag and two lateral boards. Posterior (A) and anterior (B) views. Views from the foot (C) and the top (D).

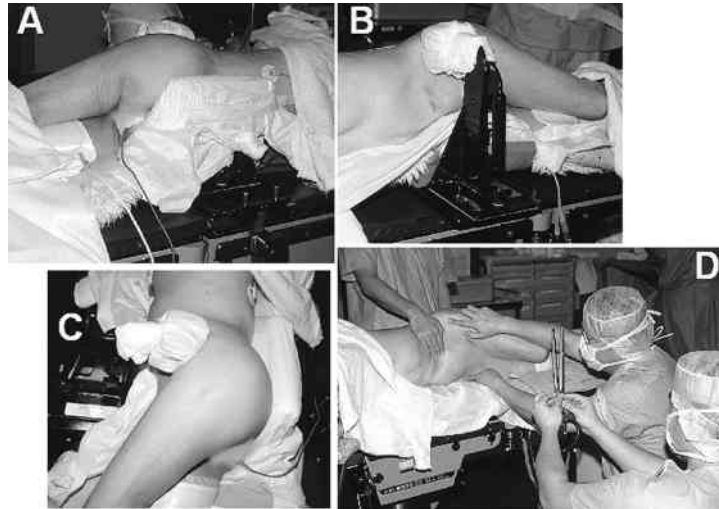


Fig. 2 Positioning using a pelvis fixation device. Posterior (A) and anterior views (B). View from the top (C). Before fixation with the device, the lateral pelvic tilt was measured (D).

tion angle in addition to the appearance of the acetabular fossa, was adjusted to the measured pelvic tilt angle. As for the vacuum bag, the lateral pelvic tilt was not measured before surgery.

The average age at surgery was 61 (32-82) years and 64 (45-79) years in groups 1 and 2, respectively. In group 1, seven patients were males and 59 were females. In group 2, eight were males and 34 were females. All patients underwent primary THA using the Kyocera PerFix Total Hip System (Kyocera, Japan), and all acetabular and femoral components were uncemented. A 22mm head was used in all hips. The postero-lateral approach was used. Operations were performed by five skilled surgeons in group 1, and by three skilled surgeons in group 2 including the senior authors. In principle, roentgen ray was not taken to decide the position of the acetabular component.

The orientation of the fixed acetabular socket was evaluated on postoperative radiographs with an anterior-posterior view

in the supine position within three months after surgery. All radiographs were taken under identical conditions at a source-to-film distance of 100cm, using the identical type of high-quality film. The abduction angle of the socket was measured directly. The anteversion angle was calculated from the ratio between the lengths of the minor and major axes of the ellipse of the socket outlet shadow using a computer software package⁵).

The average and distribution of the abduction angle or the anteversion angle were compared. In addition, the absolute value from 45 degrees was calculated in the abduction angle since the objective angle was set at 45 degrees. The objective angle for anteversion orientation ranged between 0 and 20 degrees. It varied depending on the anteversion degree of the femoral neck. Since the degree was sometimes abnormally large in the patients with acetabular dysplasia, the anteversion orientation of acetabular sockets may cause either anterior instability or dislocation. Therefore,

the absolute value for the anteversion angle was not calculated for the anteversion angle of the socket in this study.

Postoperative dislocation within three years after THA was reviewed by checking the clinical records. Revision surgeries due to repeated dislocations were also reviewed.

Any statistical difference between groups 1 and 2 was compared using the unpaired Student's *t*-tests. The probability value was considered to be significantly different when it was less than 0.05.

Results

The average abduction angle was 40 degrees in group 1, and 42 degrees in group 2. The average absolute value from 45 degrees in the abduction angle was 6.7 degrees in group 1, and 4.5 degrees in group 2. It was significantly lower in group 2 than that in group 1 ($p < 0.01$).

The cases in which the abduction angle ranged between 40 degrees and 50 degrees were 47% and 76% in group 1 and 2, respectively (Fig. 3).

The average anteversion angle was 17.4 degrees in group 1, and 10.4 degrees in group 2. In group 1, in 18% of the cases it was over 30 degrees. In contrast, there was no case was over 30 degrees in group 2 (Fig. 4).

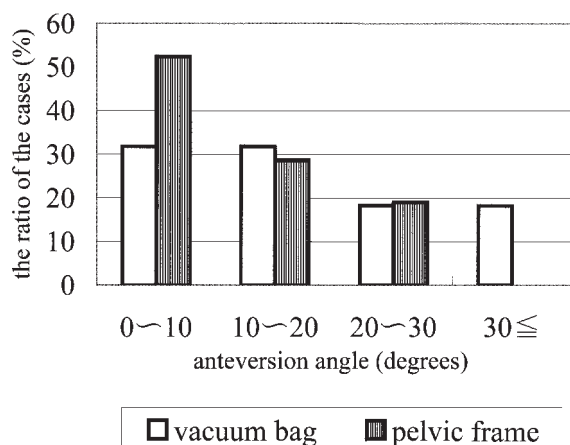


Fig. 3 Distribution of the cases according to the abduction angle.

Postoperative dislocation occurred in six cases (9%) in group 1 and revision surgery to prevent repeated dislocations was performed in two hips of the six hips. In one of the 6 cases, the abduction angle was more than 50 degrees. In contrast, postoperative dislocation only occurred in one case (2%) in group 2. The abduction angle of this case was 40 degrees, and no revision surgery was required. However, no significant difference was found between the two groups in dislocation ($p = 0.55$) and revision surgery ($p = 0.79$).

Discussion

The accuracy of the abduction angle of the acetabular sockets in the cases using a pelvic fixation device was better than that using a vacuum bag. The anteversion angle in the cases using the pelvic fixation device was more accurate than that using a vacuum bag. Postoperative dislocations were more frequent in the cases using a vacuum bag than in the cases using pelvic fixation, however no significant difference was observed between the two groups, although socket orientation is also one of the factors that influence stability.

The lateral tilt of the pelvis in lateral decubitus position was variable (data not

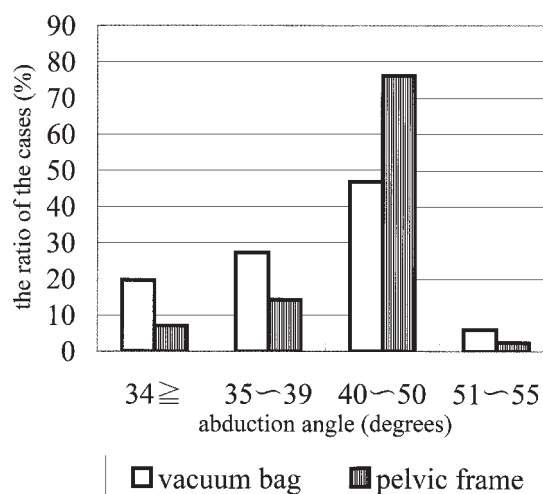


Fig. 4 Distribution of the cases according to the anteversion angle.

shown). It was therefore necessary to measure it before fixation of the pelvis in order to control the abduction angle of the socket at around 45 degrees. In some preliminary cases, the lateral tilt of the pelvis was confirmed to not change after THA by comparing the radiographs of the pelvis taken just before the operation and those taken just after it. The measurement of the preoperative pelvic tilt as well as rigid fixation provided by the device thus allows surgeons to achieve the accurate fixation of the socket.

The ideal degree or the safe range of the lateral angle of the sockets is not strongly influenced by the deformity of a proximal femur. The safe range should be between 40 and 45 degrees⁶⁾. In another report, socket orientation with a lateral angle of 40 ± 10 degrees is considered to be a safe range for preventing dislocations⁷⁾. In contrast, the ideal anteversion angle varies depending on the anteversion of the femur. The safe range of the total anteversion angle of the socket has been reported to be between 40 and 60 degrees⁸⁾. The other report using a computer analysis of THA indicates that the ideal sum of socket anteversion plus 0.7 times the stem anteversion equals 37 degrees⁶⁾. According to these reports, the anteversion of the sockets should be smaller when the anteversion of the proximal femur is abnormally large due to a deformity accompanying acetabular dysplasia. Therefore, a large anteversion angle of the socket is thus considered to be unacceptable. There are many cases in which the anteversion was more than 30 degrees in the cases using the vacuum bag in order to maintain the patient in the lateral decubitus position. As described by Woo⁴⁾, pelvic rotation during the operation may cause an inappropriate orientation of the

socket. In contrast, rigid fixation using a pelvic fixation device may prevent such a pelvis rotation, thus resulting in a decrease in the occurrence of mal-oriented sockets.

The fixation method using the pelvic fixation device enabled surgeons to more accurately control the position or orientation of the sockets with patients in the lateral decubitus position during THA in comparison to that obtained using the vacuum bag. Although the positioning and fixation of the pelvis by itself is not sufficient to control the socket orientation in order to get a good range of motion and stability of the joint, our data suggest that positioning is an important first step when performing THA procedures.

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(和文抄録)

骨盤固定器を用いた人工股関節全置換術の 寛骨臼ソケット設置の正確性について —エアー抜き固定マットと比較して—

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はじめに：人工股関節全置換術をするうえで、骨盤を確実に固定することは寛骨臼ソケット設置をコントロールする上で重要である。当科では以前、エアー抜き固定マットを用いた体位固定法を用いていたが術中骨盤の位置が変わることがあり寛骨臼ソケットの位置が十分にコントロールできていない印象があった。最近、両上前腸骨棘と仙骨にて固定する骨盤固定器を使った方法に変え、比較的良好にコントロールできていると思われる。今回、両方法による人工股関節全置換術を retrospective に比較し、寛骨臼ソケット設置が実際に改善しているかを検討した。

対象：エアー抜き固定マットを用いた1群では1997年1～12月に行われた初回THAの症例を対象とした。骨盤固定器を用いた2群は2000年1月から12月に行われた初回THAを対象とした。固定前に水平にした手術台に側臥位の状態で両上前腸骨棘を結んだ線が前額面において何度傾いているかを測定した。つぎに骨盤が前後どちらにも傾かないように注意しながら、両上前腸骨棘と仙骨を骨盤固定器にて挟んで手術台に固定した。寛骨臼ソケットの設置位置は、術後3ヶ月以内の臥位における両股関節正面像X線写真にて外方開角と前方開角で評価した。また術後3年以内の術後脱臼の有無と再脱臼予防のために再手術した症例数についても調査した。

結果：エアー抜き固定マットを用いた群では、外方開角の平均値は40°、骨盤固定器を用いた群は42°であった。45°からどれくらい離れたかを反映する45°からの差の絶対値はエアー抜き固定マットを用いた群では6.7°、骨盤固定器を用いた群では4.5°であり、骨盤固定器を用いた群がエアー抜き固定マットを用いた群に比べて、統計学的に有意に45°に近い外方開角となっていた($p < 0.01$)。前方開角の平均値は、17.4°と10.4°であった。外方開角の分布については、40°から50°の間に設置できた割合は、エアー抜き固定マットを用いた群が46.9%であったのに対し、骨盤固定器を用いた群では76.2%と高い割合を示していた。前方開角の分布については、30°以上の過度の前方開角を示した症例の割合がエアー抜き固定マットを用いた群は18.2%と高い値を示しているが、骨盤固定器を用いた群ではそのような症例は全くなかった。術後脱臼については、エアー抜き固定マットを用いた群は、66股中6股で9.1%に起こっていた。外方開角50度以上が1例、40度以下が3例であった。再脱臼予防の為に再手術例が2例であった。骨盤固定器を用いた群では42股中1股、2.3%であり、その1例の外方開角は40度で、再手術例はなかった。

考察：寛骨臼ソケットの外方開角については、骨盤固定器にて確実に骨盤を固定し、さらに骨盤の傾きを考慮することで、目標である45°に近づけることができたと思われた。前方開角については、大腿骨の前捻の程度により、必ずしも一定の角度を目標に設置していないが、30°以上の過度の前方開角を示した症例が、骨盤固定器を用いた群ではなく、前方開角についてもよりコントロールできていたものと思われた。人工股関節術後脱臼の原因は様々であるが、骨盤固定器を用いたほうが術後脱臼は少なく、比較的良好的な寛骨臼ソケットが設置できたことがその一つの原因ではないかと思われた。

結語：固定前骨盤傾斜測定を含む骨盤固定器による体位固定法は、寛骨臼ソケットの設置位置コントロールに有用であると思われた。