Acetabular Position Setting in Total Hip Arthoplasty by using V-Inclinometer

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The abduction angle of the acetabular implant position is important in the process of total hip arthroplasty. The authors evaluated the potential benefit of a V-inclinometer in the prediction of the abduction angle. To evaluate the accuracy of the V-inclinometer , acetabular cups were inserted in 50 cadaveric pelvises. The abduction angle from V-inclinometer and digital photograph were compared and analyzed using paired t-test. There was no statistical difference of the acetabular abduction angle between digital photograph and V-inclinometer (P > 0.05). The V-inclinometer can be used to predict the abduction angle on a cadaveric pelvis, suggesting that it could be a useful adjunct in clinical practice.

Keywords : *Abduction angle, Total hip arthroplasty, V-inclinometer, Digital photograph*

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Achieving the correct degree of an abduction angle of the acetabular component is importment in total hip arthroplasty (THA). Intraoperative difficulties or technical errors can alter the outcome significantly. The component orientation is critical for preseving the range of motion and prevent dislocation[1]. It has been reported that the cup malpositioning is associated with an increased risk of impingement and limted range of hip motion[2,3]. The vertical acetabular component angle (high abduction angle) resulted in increased polythelene wear rate, pelvic osteolysis and acetabular migration (aseptic loosening)[4]. The explanation for early loosening in this context is abnormal joint loading from vertical acetabular component angle. A vertical cup position will lead to abnormal stress concentration in the outer edge of the bone implant interface with an increase in shearing forces[5]. The acetabular abduction angle of between 45 and 55 degrees premitted a better overall range of motion and stalility[2], decreased polyethelene wear rate[4]. The osteolysis of the ilium was associated with a lateral opening of the acetabular component of more than 50 degrees[6].

Lewinek et al[7] advocated the range of acetabular angle between 30^0 to 50^0; outside this "safe" range the dislocation rate was increased. The position of the acetabular component is estimated by aligning the insertion rod to the body axis of the patient, to anatomical landmarks, or to other reference points[8]. The adjustment of the abduction angle of the acetabular component by visual perception is subjective and lacks precision[9].

Therefore, the authors designed the V-incliometer for positioning the cup. The V-incliometer can be attached to the insertion rod of the acetabular component (Fig. 1). The objective of this study was to determine the accuracy of the V-inclinometer in positioning the cup on a cadaveric pelvis.

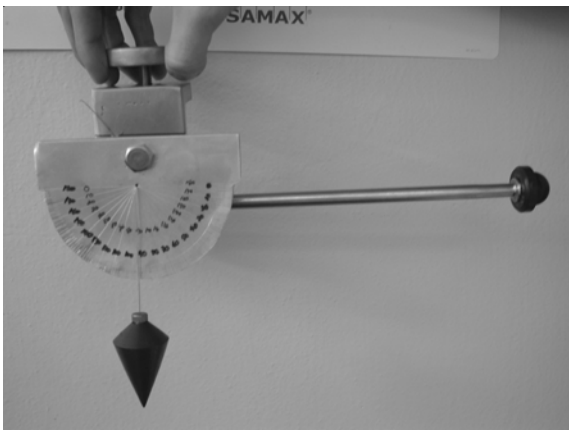

Fig. 1 V- inclinometer installed on an insertion rod

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Fig. 2 V-inclinometer with insertion rod attached on the acetabular cup

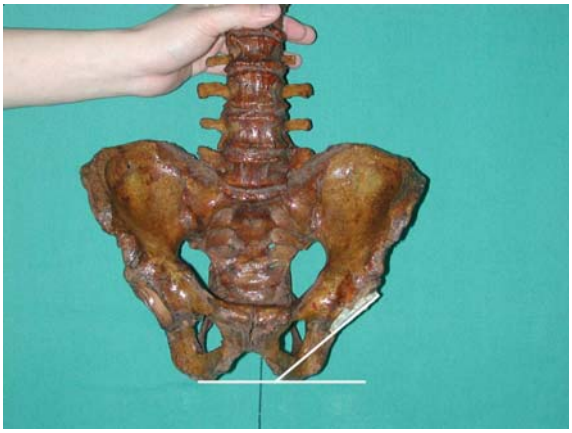

Fig. 3 Measurement of the acetabular cup angle in digital photograph

Material and Method

The V-inclinometer is made of sterilizable stainless steel and is attached to the acetabular insertion rod by a hand-tightening screw. The instrument is scaled from 0^0 to 180^0 at 1^0 intervals. The degree of the abduction angle is determined by the displacement of a pendulum under gravity (Fig. 2). The V-inclinometer scale is adjustable and is able to be set at 0^0 parallel to the acetabular insertion rod.

The authors used a 45 mm cup secured to the reamed cadaveric acetabulum with cement The cadaveric pelvis was supported at 90^0 to the plane of a table in the lateral decubitus position. The authors measured the angle of abduction of the cup by using V-inclinometer. After each insertion, an anteroposterior digital photograph was taken. During each photograph, the distance between the camera and the cadaver was maintained. Study participants were 2 orthopaedic residents and 1 orthopaedic surgeon. The participants completed a total of 50 trial insertions.

The abduction cup angle was measured on digital photograph by using Adobe® photoshop™7.0 program (Fig. 3). The angle was measured between the lower margins of the ischial tuberosities and the longitudinal axis of the outer cup[10]. All measurements were done by a senior resident who was blinded to each intervention group photograph. Statistical analysis was performed on a personal computer with SPSS offware (SPSS, Chiago, Illionis). The mean difference between the V-inclinometer method and digital photograph was evaluated by paired samples t-test. The confidence intervals presented are 95% and the significant level aecepted was $p > 0.05$.

Results

The results of the 50 trials done with V-inclinometer showed the components were positioned at the mean angle of 44.26 degrees (SD = 17.8186). The mean angle of digital photographs was 43.88 degrees (SD = 18.3004). The difference between the mean angle of vertical positioning determined by both methods was found to have no statistical difference (P = 0.110). The 95% confidence interval of the ratio of the SDs of the two positioning methods showed that using the V-inclinometer represented the true position of the cup on a cadaveric model (P > 0.05) (Table 1).

Discussion

The acetabular component orientation is an important step in prediction of the outcome of THA. Many authors recommended the abduction angle between 40^0 and 50^0 for metal-on-polyethylene THA[2,3,7,8,11-13] and 35^0 and 45^0 for ceramic-on-ceramic THA[14]. Acetabular abduction angles of less than 45^0 tended to decrease hip flexion and abduction[2]. Higher acetabular abduction angles increased hip flexion and abduction but may reduce extension, abduction and external rotation[2]. Vertical orientation of the acetabular component is associated with high polyethelence

Table 1. Comparisions between V-inclinometer method and digital photograph

	V- inclinometer method	Digital photograph
No. hips	50	50
Mean abduction angle	44.26 degrees (SD = 17.8186)	43.88 degrees (SD = 18.3004)

* P > 0.05

wear rate[15]. There are four ways to position the acetabular component in a safe position. Firstly is to use a reference rod attached at 45^0 to the insertion rod. This system is easy for the surgeon to do but it lacks precision[9]. The second is to confirm positioning with a intraoperative radiograph. This technique has potential disadvantages, including an increased risk of contamination. The third is a computer-assisted technique[16]. So far the latter technique is the most accurate for positioning the acetabular component but it is time-consuming and too costly. The fourth is of course the use of an inclinometer, as shown in the present study.

In the present study, all the positions of the cups arrenged by V-Inclinometer were predictable. The authors compared the angle from the V-inclinometer with the true position of the cup by digital photography, because it presents the exact vertical orientation of the acetabular trial.

The use of a V-inclinometer during THA will never replace careful preopertive surgical planning and systematic evaluation of cup position according to anatomic landmarks during surgery. This instrument represents a helpful adjunct to the surgeon, increasing the probability of positioning the cup within a safe position and avoiding malpositioning.

The V-inclinometer may be especially useful when anatomic landmarks are deficient, as is the case in hip dysplasia or revision situations.

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เครื่องมือ V-inclinometer ช่วยการวางตำแหน่งของ acetabular cup ในการทำผ่าตัดเปลี่ยนข้อตะโพก

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ได้ประดิษฐ์เครื่องมือ V-inclinometer เพื่อใช้ในการทำผ่าตัดเปลี่ยนข้อตะโพก โดยทำการศึกษาหาความแม่นยำของเครื่องมือที่สามารถบอกค่าของ acetabular cup angle ในระหว่างการตั้งข้อเทียมโดยการเปรียบเทียบที่ได้จากการวัดจากเครื่องมือ V-inclinometer กับมุมที่ได้จากการคำนวณ จากรูป digital photograph ในกระดูกเชิงกรานจากศพ 50 ราย ซึ่งไม่พบว่ามีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ (P > 0.05) ของทั้ง 2 วิธี

การศึกษานี้พบว่า การใช้ เครื่องมือ V-inclinometer สามารถช่วยในการตั้งมุมของ acetabular cup และนำไปใช้ได้ในการทำผ่าตัดจริง