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## 27.1 Author

Lewinnek GE, Lewis JL, Tarr R, Compere CL, Zimmerman, JR.

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## 27.2 Reference

*J Bone Joint Surg Am.* 1978;60:217–220.

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## 27.3 Institution

Northwestern Memorial Hospital. Chicago

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## 27.4 Abstract

In this review of 300 total hip arthroplasties there were 9 hip dislocations. These dislocations were analysed by performing measurements of the acetabular cup angle. It was found that an increased acetabular component anteversion angle was seen in anterior dislocations. A dislocation rate of 1.5 % occurred for cup orientation with anteversion of  $15^{\circ} \pm 10^{\circ}$  and lateral opening of  $40^{\circ} \pm 10^{\circ}$ .

Acetabular orientation that did not lie within these value ranges, was associated with a dislocation rate of 6.1 %. It was found that dislocation was more likely to occur if less than 30 days had passed since surgery and if the hip had been operated on previously. Posterior dislocation was not found

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to have any significant relationship with acetabular cup orientation.

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## 27.5 Summary

Lewinnek et al. report a 3 % dislocation rate in a series of 300 total hip arthroplasties (THA). Anterior dislocations were associated with increased acetabular component anteversion

The authors describe a safe range ( $5\text{--}25^{\circ}$  anteversion and  $30\text{--}50^{\circ}$  abduction) to position the cup. The dislocation rate for implants outside this range was four times higher than for those within the range (6 % versus 1.5 %).

Significant factors affecting dislocation included acetabular component orientation, surgeon experience and a history of previous surgery.

Significant concerns with study methodology weaken the studies conclusions.

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## 27.6 Citation Count

562

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## 27.7 Related References

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## 27.8 Key Message

Lewinnek et al. report a safe margin for cup orientation of anteversion of  $15^\circ \pm 10^\circ$  degrees and lateral opening of  $40^\circ \pm 10^\circ$ . Outside this safe zone the risk of dislocation significantly increased.

## 27.9 Why It's Important

Instability is the second most common complication of total hip arthroplasty (THA) after aseptic loosening. Reported dislocation rates vary from 0.5 to 11 % with 3 % being an accepted value. Correct alignment of the acetabular component during THA is a crucial step for reducing the chances for joint dislocation.

Acetabular component orientation has been shown to be a significant factor affecting the risk of dislocation, impingement, pelvic osteolysis, acetabular migration, and wear between components in patients undergoing THA [1].

Incorrect orientation of the acetabular component is thought to be the most important factor predisposing to hip dislocation [2].

## 27.10 Strengths

Although other papers had reported on acetabular component positioning and risk of dislocation Lewinnek introduced the term "safe zone". Despite serious limitations with the safe zone concept, this paper is frequently cited in hip dislocation studies [3, 4].

## 27.11 Weaknesses

Despite being a well known and often referenced paper it is significantly limited by flawed methodology in a number of different areas.

Patients who had revision surgery were mixed with those who had primary surgery. It is apparent from looking at the results that many of the dislocated patients had undergone previous surgery of the hip. Also, the experienced surgeons had lower dislocation rates despite the fact that many of their patients were outside the safe zone.

The studies recommendations were based on only nine dislocations where measurements of acetabular cup anteversion were made using an invalidated radiographic method

No recommendations were made in the study as how to reduce the incidence of dislocation.

The patient numbers in the series were small at 300 compared to some much larger studies published [5, 6].

Five surgeons with different experience levels performed the THA's. Surgeon experience is a known factor, which affects THA dislocation rate. Hedlundh and coworkers [7]

showed a reduction of dislocation rate by 50 % for every ten primary arthroplasties performed yearly. They also showed a high dislocation rate among surgeons who perform less than 30 cases a year

The standard technique used by the five surgeons was a posterolateral approach although surgeons varied in whether they repaired the external rotators at the end of the procedure. Investigators have shown reconstruction of the posterior capsule and short external rotators after a posterior approach significantly decreases the dislocation rate to comparable levels to other approaches [8]. White et al. [9] demonstrated a reduction from 2.8 to 0.6 % in 1,000 patients; Goldstein et al. [10] reported a decrease from 4.8 to 0.7 % in 1,515 patients; and Pellicci et al. [11] reported a reduction from 4.1 to 0 % in 395 patients with posterior capsular repair.

No mention was made of femoral stem orientation, which has also been shown to affect the dislocation rate. Fackler and Poss [12] identified excessive femoral anteversion as the most common implant malposition. In their study, implant malposition was present in 44 % of patients with dislocations (15/34) but in only 6 % of those without dislocation (3/50) ( $P < 0.05$ ).

Acceptable acetabular version is also determined by the amount of femoral version, the surgical approach, and the individual anatomy of the patient. In addition knowledge of the various landmarks in the pelvis and hip in the lateral decubitus position is needed to avoid malpositioning the acetabular component. These issues were not explored in the paper.

## 27.12 Relevance

This was a consecutive series of 300 THA's performed by multiple surgeons in a single institution. Information about the patient's age, diagnosis and acetabular component orientation was obtained for the 9 hips that had dislocated. Only 113 of 291 hips in which the prosthesis did not dislocate were studied. This was because the radiographs could not be obtained.

Of the 113 non-dislocated hips the diagnosis varied considerably from osteoarthritis (59), failure of previous surgery (16), rheumatoid arthritis (14), ankylosing spondylitis (3), avascular necrosis and developmental dysplasia hip.

A standard posterolateral approach was used by all surgeons. Only one surgeon reattached the external rotators during closure. This surgeon used the Aufranc-Turner prosthesis only, the other surgeons used either the Aufranc-Turner or Charnley-Muller prostheses.

The orientation of the radiolucent cup was determined from the elliptical appearance of the circular marker wire. The lateral opening angle,  $\theta$ , was measured directly. The anteversion angle,  $\alpha$ , was calculated from the ratio between the lengths of the minor and major axes of the ellipse.

There have been numerous reports on the optimal orientation of the acetabular component in THA with a wide variety of best parameters. Harris [13] suggested an abduction angle of  $30^\circ$  and anteversion angle of  $20^\circ$ , Harke [14] recommended an abduction angle of  $45^\circ$  and anteversion angle of  $15^\circ \pm 5^\circ$ . Barrack [15] defined an acceptable range of  $45^\circ \pm 10^\circ$  abduction and  $20^\circ \pm 10^\circ$  anteversion.

However, most surgeons would aim for an acetabular component alignment of  $40^\circ \pm 10^\circ$  abduction and  $15^\circ \pm 10^\circ$  operative anteversion (also known as flexion) with respect to the anterior pelvic plane (APP).

McCollum and Gray [16] reported that accurately aligning the pelvis with the patient in the lateral decubitus position is an almost impossible task. They also reported that pelvic malalignment could lead to improper cup alignment. They indicated that pelvic flexion and soft tissue contractures can result in changes in native acetabular orientation from the apparent position of the patient on the operating table and may lead to component malposition. They recommended cup anteversion of  $20\text{--}40^\circ$  rather than the  $5\text{--}25^\circ$  proposed by Lewinnek et al.

Femoral version complicates the issue of acetabular cup orientation. Ranawat introduced the concept of combined anteversion of the stem and cup [17]. With the cup and stem in place, the lower limb is positioned in neutral (or slight hip flexion) and is internally rotated until the femoral head is symmetrically seated (coplanar) in the cup. The amount of internal rotation in degrees needed to produce a coplanar head and cup is the combined anteversion [18].

Ranawat and Maynard [19] recommended a combined anteversion of approximately  $45^\circ$  in female patients and  $20\text{--}30^\circ$  in male patients. Dorr et al. found the safe zone for combined anteversion is  $37^\circ \pm 12$ . This value is lower in men than women mostly because femoral anteversion is lower in men (mean  $8.7^\circ$  in men versus  $10.7^\circ$  in women).

Dorr et al. [20] investigated combined anteversion of THA using computer navigation. They believe there is a wide safe zone of  $25\text{--}50^\circ$  for combined anteversion for THA which explains why most THA's are successful. They believe measurement of the acetabular position alone is not diagnostic of the cause of dislocation [3].

Combined anteversion explains why a hip remains stable throughout the wide flexion arc ( $35^\circ$ ) of the acetabulum in the change of body position from supine to sitting [21].

They concluded that reference to a safe zone for THA in the future should be to combined anteversion, rather than isolating a safe zone for the acetabulum.

Finally although we can recommend certain ranges of angles for cup abduction and anteversion or stem anteversion to achieve hip joint stability other factors, including muscle weakness, surgical approach, detachment of the greater trochanter, head size, and type of acetabular liner, also affect dislocation. Some studies have failed to show a significant correlation between position of implants and occurrence of dislocation [22].

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