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CORR Insights®: Does Degenerative Lumbar Spine Disease Influence Femoroacetabular Flexion in Patients Undergoing Total Hip Arthroplasty?

Lawrence D. Dorr MD

Where Are We Now?

Lazennac and his colleagues [4, 5] were the first to inform the orthopaedic community about the importance of the spine-pelvic-hip relationship. Hip surgeons had not considered that the acetabulum changed position with postural change. They described the tilt of the pelvis being connected to the lordosis of the spine. Therefore, the pelvis was tilted anteriorly when standing with the

acetabulum relatively closed. When sitting, the pelvis tilts posteriorly as the spine straightens, and the acetabulum opens with both inclination and anteversion to allow clearance of the flexed femur. Their research showed that spinopelvic mobility was crucial to avoiding impingement of the components of the hip replacement, or bony impingement, during both extension and flexion of the hip. If there is spinal imbalance such as degenerative disc disease with either

stiffness or hypermobility of the spine/pelvis in 40% of their patients undergoing hip replacement, as described by the authors of the current study, it translates to a change in the pelvic mobility, which changes the acetabular opening between standing and sitting. In these patients, total hip replacement surgeons must control the acetabular opening mechanically with both the inclination and anteversion of the cup to compensate for the spinal imbalance that is present. Imbalance is undoubtedly higher in patients who require revision hip replacement because as patients age, their spine becomes stiffer.

I was on a team that previously published on spinal imbalance [2]. We studied patients before they underwent total hip replacement, and classified the three types of spinopelvic motion as normal, stiff, or hypermobile [2]. Surgeons should not dismiss spinopelvic motion just because they have a low dislocation rate, as spinal imbalance causes prosthetic impingement, which causes problems other than

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L. D. Dorr MD (✉)
Keck Medical Center of USC, 1520 San Pablo Street, #2000, Los Angeles, CA 90033, USA
e-mail: Lawrence.Dorr@med.usc.edu; patriciajpaul@yahoo.com

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instability. These issues could include pain, which is often diagnosed as unexplained [6], and edge loading and accelerated wear, which are intensified with hard-on-hard articulations such as metal-on-metal [1, 3, 8].

Where Do We Need To Go?

Surgeons are just beginning to learn about this relationship between cup

position and spinopelvic mobility, and are confused about the importance of spinopelvic imbalance. We need greater awareness of the connection between the spine, the pelvis, and the hip as it relates to the functional position of the cup during total hip replacement. There is new terminology such as pelvic incidence, sacral tilt, pelvic femoral angle, and implant positions of ante-inclination and sacral acetabular angle—all of which

magnify the confusion (Fig. 1). It is important for the orthopaedic surgeon to learn that he/she controls the mechanical opening of the acetabulum (cup) when spinal imbalance is present, and if the cup position is not balanced with the pelvic motion then impingement occurs. Surgeons should learn to obtain lateral spinopelvic radiographs for selected patients, such as those with spine fusions or a history of back disease/pain, even if they elect

Fig. 1A–B An illustration of the standing position of the spine-pelvis-hip construct with the important angle measurements is shown. **(A)** The pelvic incidence (the measurement of the width of the pelvis) is 55°, and is the same standing or sitting. With standing, the pelvis is tilted anteriorly. The sacral tilt (also called sacral slope) is a dynamic measure of the spinopelvic motion (normally 40° standing). The pelvic femoral angle is the relationship of the spinopelvic motion and hip motion (normally 180° $\pm$ 10° extension when standing; in the standing image here, it is at 190°). **(B)** An illustration of the sitting position of the spine-pelvis-hip construct. The pelvis tilts posteriorly with sitting (notice the flattened pelvic brim). The normal sacral tilt is 20° sitting (a Δ sacral tilt of 20° between standing and sitting). The pelvic femoral angle sitting shows flexion to 125° $\pm$ 10°.

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not to do them as a routine preoperative evaluation [7]. This should be done to incorporate imbalance in their decision-making for cup placement, which becomes particularly important in patients who have had dislocation or who are having revision hip replacement. In their study, Esposito and colleagues found that spinopelvic imbalance is present in 40% of patients undergoing primary operations.

Because of this, we should now obtain these radiographs as a routine preoperative evaluation. Obtaining radiographs helps us understand what the cup position should be for those patients, and because we use computer navigation intraoperatively, we can precisely obtain that cup inclination and anteversion at surgery (Fig. 2). However, other orthopaedic surgeons use fluoroscopy, digital radiographs,

and individual methods to achieve their precision. It is important that surgeons do not use a “one size fits all” philosophy, and put all cups at 40° inclination, 20° anteversion, for instance. Knowledge of the influence of spinopelvic motion on the risk of impingement of the hip replacement emphasizes the importance of personalizing the cup position at least for patients at increased risk.

Fig. 2A–B A radiograph of the standing lateral spinopelvic-hip displays the skeletal and implant measurements of a patient with stiff spinal imbalance from spinal stenosis with loss of disc spaces. **(A)** The pelvic incidence is at a low normal of 50°. The sacral tilt is 10°, which is below the normal range and indicates excessive posterior tilt of the pelvis (notice the flattened pelvic brim). The pelvic femoral angle is 209°, creating risk for anterior dislocation due to excessive extension. With excessive posterior tilt, hyperextension is necessary for the patient to stand straight, but it risks posterior impingement. Ante-inclination (the combined inclination and anteversion of the cup) is 49° standing in this patient, which is above normal (35° +/– 9°). The sacral acetabular angle (a measure of the relationship of the acetabular opening to spine motion) is 59°. Although static for both standing and sitting, 59° is below the normal range (74° +/– 9°). The below normal sacral acetabular angle is likely due to the excessive posterior tilt of the pelvis, which can indicate an increased risk for bony impingement. **(B)** A radiograph of the sitting lateral spinopelvic-hip construct in a patient with stiff spinal imbalance. The pelvic incidence is 53° and is different from the standing because of rotation of the radiograph. Sacral tilt is 8° (representing a Δ sacral tilt of 2° from the standing image in **A**), indicating a fused spine (biological fusion in this patient). The pelvic femoral angle sitting is 136° because the pelvis is tilted so far posteriorly. A 51° ante-inclination is in the normal range (53° +/– 9°). However, the Δ ante-inclination between standing and sitting is only 2°, indicating a stiff acetabulum. Because of the stiffness, almost all of the mobility of the spinopelvic-hip construct is at the hip and this increases risk for impingement. The sacral acetabular angle is 59° and is the same standing and sitting.

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How Do We Get There?

Moving forward, I would like to see an increase in the number of studies that are done about spinopelvic mobility. I am on a research team that is correlating the imbalance to cup position using computer navigation. But it will be important that studies are also done by surgeons who use manual placement of the cup to learn if this method can adequately position the cup to compensate for severe imbalance, particularly in patients with surgical or biological fusion of the spine, surgery for dislocation, and revision hip arthroplasty. Surgeons need to study a series of patients in whom cup placement is correlated to the ante-inclination and sacral acetabular angles that are achieved, and follow these patients for 5, 10 and 20 years to fully understand the consequences of outliers from normal measurements in different postural positions. Clinical research should study both the posterior and anterior approaches because surgeons that use these approaches sometimes differ in their cup placement. A study reporting on dislocation and its relationship to spinopelvic imbalance would likely require a multicenter research project to provide a sufficient number of cases. A multicenter study would help surgeons understand which patients are ideal for dual-mobility articulations. There are

no articles of which I am aware that give confidence that the dual-mobility articulation is safer than conventional articulations for longevity of 30 years to 40 years. Young patients are still better treated with conventional articulations, unless we are certain they are at risk for recurrent dislocation, because the wear rates with highly crosslinked polyethylene are proving to be low annually [9]. These are all fertile areas of study for the ideal understanding of this new area of knowledge.

Lazennac and his colleagues deserve our thanks for introducing this frontier to us, and Esposito and colleagues deserve thanks for increasing our awareness of spinal imbalance in the present article.

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