Lumbar Spinal Stiffness Overshadows Polyethylene Wear: A Modern Explanation for Late Dislocation in Total Hip Arthroplasty

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Submission: May 22, 2018; Published: May 30, 2018

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Introduction

Instability or dislocation after total hip arthroplasty (THA) is a dreaded complication, occurring with rates ranging from 0.3% to 10% [1-4], and is the most common reason for revision surgery [5]. Risk factors for instability following THA include patient-specific factors such as non-compliance, neuromuscular or cognitive disorders, as well as surgical considerations including approach [6], soft tissue tension, component size; positioning, implant choice and polyethylene wear [7]. Traditionally, it is thought that the THA dislocation occurs in a bimodal distribution, based on timing after surgery (early and late). Early dislocations, which occur within the first two years following THA, are more common than late dislocations, and are more commonly attributed to component malposition [8], patient non-compliance (drug abuse or dementia) or neurocognitive disability (Parkinson Disease), or conditions affecting soft tissue quality and tension including soft tissue repair, rheumatoid arthritis and a vascular necrosis [9-11]. Late THA dislocations, which usually occur many years after THA, have been largely attributed to (based on our classic adult reconstruction teaching dogma) eccentric polyethylene wear [12].

There is evidence that the rates of both early and late dislocations have declined substantially in the past decade [11] which has coincided with improvements in bearing surfaces, more frequent use of larger diameter femoral heads and improvements in surgical technique including posterior soft-tissue capsular repair [7,13,14]. One improvement in particular is the increasing use of highly cross-linked polyethylene liners, which have demonstrated very low linear and volumetric wear rates at long-term follow-up [15], even in conjunction with the increasing use of larger diameter metal heads [16]. These low wear rates have been shown to result in greater implant survival, less osteolysis and revision for aseptic loosening compared with the use of conventional polyethylene over the long-term [17-20]. Although there is no definitive evidence, it is likely that this low wear rate also contributes to the observed decrease in late THA dislocations given the improved survivorship of highly cross-linked polyethylene over conventional polyethylene. Moreover, with the superior wear characteristics of highly cross-linked polyethylene liners, the use of larger femoral head diameters (>=36mm), which are associated with a lower dislocation risk, has become a widely practical option [21,22].

While polyethylene wear has been the traditionally highlighted factor in late THA instability, there is increasing evidence and emphasis on the association between THA dislocation and changes in a patient’s sagittal lumbo pelvic alignment. Spino-pelvic kinematics, sagittal alignment, and spinal balance are prone to change over time in the setting of progressive degenerative changes of the lumbar spine, or acutely in the setting of a lumbar spinal fusion. These changes have a profound effect on the dynamics between the lumbar spine and the pelvis during different postural positions (eg. from sitting to standing). Biomechanically, lumbar spondylosis typically results in decreased lumbar lordosis, and posterior pelvic tilt, causing degenerative flat back deformity [23].

The effect of the resulting pelvic retroversion is an increase in acetabular cup anteversion and abduction. The opposite is true following long segment spinal fusion for spinal deformity which results in increased lordosis, anterior pelvic tilt and reduced acetabular anteversion [24]. In lumbar hyperlordosis, sacral slope and anterior pelvic tilt increase, resulting in decreased acetabular version and inclination. Coupled with a fused and therefore stiff spine, this results in increased risk of posterior hip dislocation [25,26]. For each of these scenarios, one degree of posterior pelvic tilt has been shown to increase acetabular anteversion by 0.74 degrees [27]. These relationships are also dynamically related to postural changes from standing to sitting. Sitting decreases pelvic tilt and sacral slope, and therefore increases acetabular retroversion and abduction [28]. In a flexible spine, particularly in patients with a high pelvic incidence, the pelvis tilts posteriorly in sitting. These results in
increased acetabular anteversion, improved posterior coverage of the femoral head, and therefore are protective against posterior dislocation. However, in a stiff, degenerative spine, or in the case of lumbar fusion, posterior pelvic tilt is limited, and therefore the risk of prosthetic hip instability is higher due to anterior femoracetabular impingement and reduced posterior coverage.

Increased risk of THA instability has been demonstrated in multiple studies with patient cohorts having degenerative lumbar spinal disease [29-32], with an estimated rate of 3-7% in those with lumbar fusion [33-35]. In particular, patients experiencing total hip arthroplasty dislocation were noted to have more fixed spinopelvic alignment between standing and sitting, with fewer changes in lumbar lordosis and pelvic tilt. Although several of these studies have noted THA dislocations in early follow-up, particularly in the setting of lumbar fusion, it is likely that late THA dislocations are increasingly seen in individuals who develop lumbar spondylosis and stiffness over long-term follow-up from their primary THA [25]. More longitudinal studies examining late THA dislocations and changes in lumbo-pelvic alignment over time are needed to validate this inference. Over the past two decades, as late THA dislocation rates improved secondary to improved bearing surfaces and less polyethylene wear, the attention is shifting towards THA dislocations associated with progressive degenerative lumbar spinal disease. There is no currently available data to compare the risk of late dislocation from highly cross-linked polyethylene wear to that from lumbar spinal disease, but it is likely that the modern trend is shifting to the latter carrying a higher risk.

The clinical implications of these changes in trends of late THA dislocations warrant attention. With lumbar spinal stiffness and alignment becoming a more important factor in predicting the risk of total hip dislocation, there is an increasing need to appropriately evaluate a patient’s lumbar sagittal alignment and flexibility prior to undergoing THA. The use of sitting and appropriate evaluation of a patient’s lumbar sagittal alignment becomes a more important factor in predicting the risk of total hip dislocation, there is an increasing need to accurately evaluate a patient’s lumbar sagittal alignment and flexibility prior to undergoing THA. The use of sitting and standing imaging has been growing in popularity to evaluate spinopelvic parameters pre-operatively and can guide the surgeon to planning cup position and implant choice, to decrease dislocation risk.

Conflicts of Interest

There are no conflicts of interest or disclosures relevant this work.

References


