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Case report

Late posterior hip instability after lumbar spinopelvic fusion

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A R T I C L E I N F O

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A B S T R A C T

The kinematic relationship between the hip and the axial skeleton is dynamic and can be variable based on individual anatomy. It has been shown [1] that pelvic incidence (sacral slope + pelvic tilt) can be used as a proxy to determine the ability of the pelvis to accommodate changes in sagittal balance. Individuals have varied pelvic incidence and thus may adapt differently degenerative and/or iatrrogenic to changes that occur in the axial spine. This is a case report in which surgical changes to the lumbopelvic spine resulted in chronic posterior periprosthetic hip instability. The focus of this discussion reflects the intimate relationship between the hip and spine and highlights the role between sagittal balance and acetabular version, specifically as it pertains to total hip arthroplasty.

Introduction

Instability after primary total hip arthroplasty remains a common reason for revision [2]. Contributing causes include patient specific factors [3–5], surgical technique [5,6], and implant choice [7,8]. Patient factors such as age, gender, obesity, cognitive disability and neuromuscular disease as well as previous hip surgery have all been reported to be potential risk factors for post-operative instability [5,9–13]. Surgical technique is paramount to decreasing the risk of dislocation however there is controversy as to the ideal positioning of implants, approach, and soft tissue management [6,14]. With improvement in the production of bearing surfaces and the use of alternative materials such as ceramics, it has been suggested that osteolysis related failures have the potential to decrease [15–17]. Recently, biomechanical analysis and advanced imaging have given us a better understanding of the relationship between spinal sagittal balance and acetabular orientation. Acetabular placement is often based on a standing AP pelvis film taken preoperatively in conjunction with intra-operative landmarks. The standing radiograph provide a snapshot of native acetabular version which is in part determined by lumbar lordosis and can be used to help guide implant version. Sagittal balance however, changes over time through degenerative changes in the spine as well as iatrogenically from spinal fusion. In addition, the dynamic relationship between the spine and the pelvis during positions such as sitting and standing must be taken into account. The focus of this report is to describe a case of posterior hip instability following a change in sagittal balance resulting from a spinopelvic fusion.

Case history

A seventy-three year old female underwent left primary total hip arthroplasty through a posterior approach for end stage coxarthrosis secondary to femoral dysplasia and concomitant inflammatory arthropathy (Figure 1). Pertinent medical history included rheumatoid arthritis, type 2 diabetes, chronic obstructive pulmonary disease, and depression. Her prior surgical history included an L3-L5 posterior lumbar interbody fusion four years prior for degenerative spondylolisthesis with lumbar stenosis. She had an uneventful post-operative course following her left hip arthroplasty and progressed well with physical therapy. At her one and three-month follow up visits she stated that her left groin pain that she complained of prior to surgery had completely resolved.

The patient did, however continue to have discomfort in her lumbar spine as well as bilateral buttocks which continued to worsen over the following two years. Lateral lumbar spine radiographs revealed progressive proximal junctional kyphosis but she remained very satisfied with her hip surgery (Figure 2). After failure

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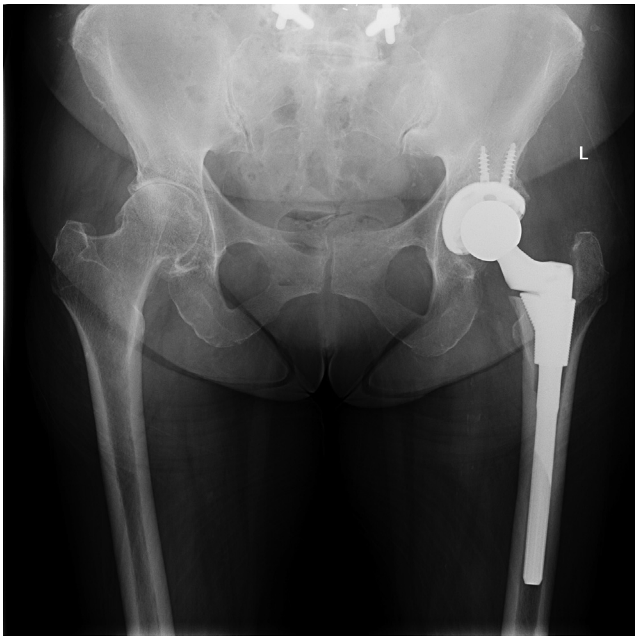

Figure 1. Standing AP pelvic radiograph after left total hip replacement.

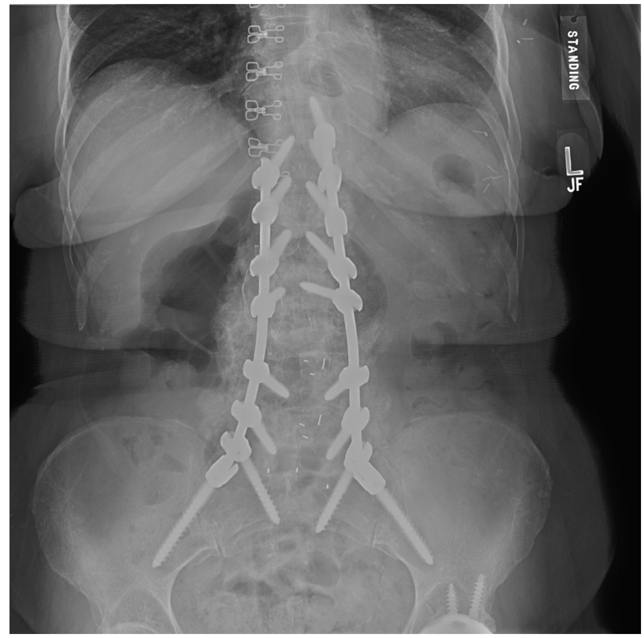

Figure 3. Standing AP Spine radiographs following instrumented T10 to Ilium fusion.

of all conservative management, she underwent revision lumbar surgery with an L3 pedicle subtraction osteotomy and instrumented fusion from T10 to ilium three years after her primary total hip arthroplasty (Figure 3). She was discharged home and had an uneventful postoperative recovery. However, five weeks after spine surgery she sustained a posterior left hip dislocation while squatting in her bathroom (Figure 4). She underwent closed reduction under anesthesia and was placed into a knee immobilizer. Her knee immobilizer was removed after 4 weeks and she presented two weeks thereafter with a subsequent posterior dislocation which was also closed reduced. The only pertinent change in this patient's history over this timeline was her revision lumbar pelvic fusion resulting in a fixed, increased lumbar lordosis. A long discussion was held with her and together we elected to attempt continued conservative management. Despite a soft abduction brace and reinforcement of posterior hip precautions she sustained three additional dislocations over the following two months. At this point revision surgery was again discussed and the patient elected to proceed.

Surgical options that were discussed with the patient included increasing the version of her modular stem and the use of a face changing liner versus acetabular revision with the potential for a dual mobility cup and/or a constrained liner. At the time of surgery,

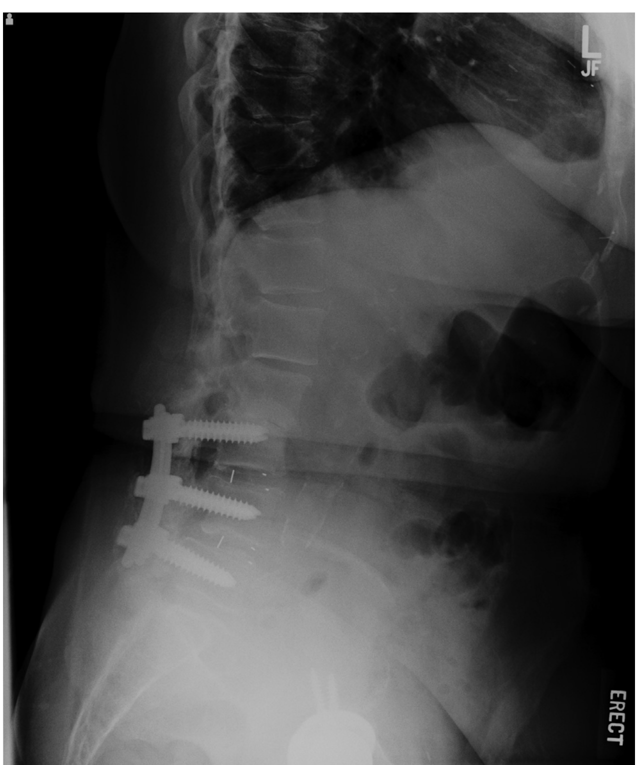

Figure 2. Standing lateral radiograph of the lumbar spine demonstrating previous L3 to L5 posterior fusion and development of adjacent segment disease and junctional kyphosis at L2.

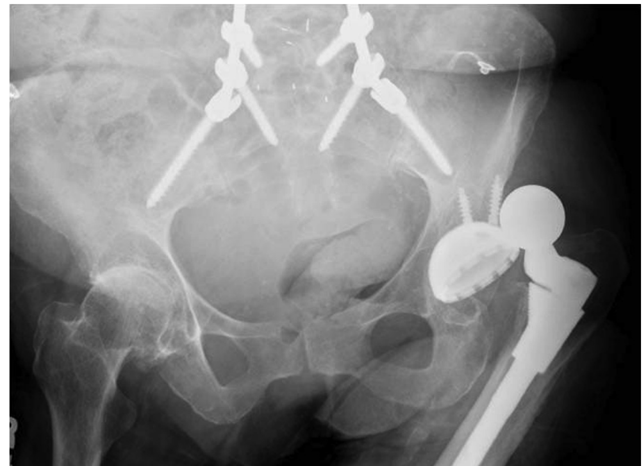

Figure 4. AP pelvic radiograph rays following posterior hip dislocation five weeks after lumbopelvic fusion.

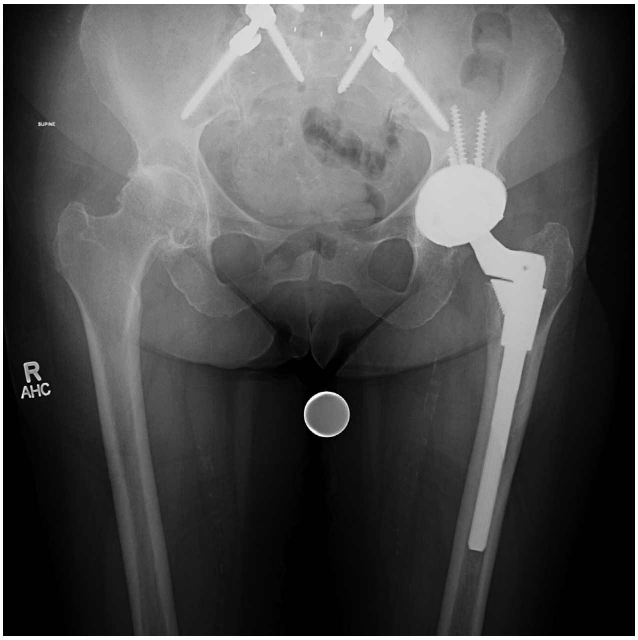

Figure 5. Postoperative AP pelvis radiograph following acetabular revision.

the SROM (DepuyWarsaw, IN) femoral component was noted to be appropriately anteverted however the hip was noted to dislocate with less than 5° of internal rotation. The position of the cup was marked and the cup was then explanted. A revision shell was placed and trialed with approximately twenty degrees of increased anteversion. Stability was noted to be significantly improved. Because of the previous five dislocations there was minimal posterior capsular tissue to repair and thus the decision was made to place a dual mobility head ball and liner to minimize the chance of future dislocation (Figure 5). Weight bearing was initially protected and gradually increase over the first six weeks post-operatively. At her three and six month visits she was doing very well with no further dislocations.

Discussion

The role of the pelvis as an intercalary segment between the axial spine and the lower extremities is complex and its position in space is dynamic. A standing AP radiograph has been the standard by which most surgeons plan preoperatively for acetabular component positioning. Using this information along with intraoperative bony landmarks, components are placed accordingly to lie within a previously suggested safe zone of 40 ± 10° abduction and 15° ± 10° of anteversion based on anatomic studies published by Lewinnek et al. [18]. While total hip arthroplasty has been reported to have greater than a 95% success rate with more than ten year follow up, dislocation continues to be one of the most common post-operative complications [19].

In a normal flexible pelvis, there is a change in pelvic tilt in the anterior and posterior plane. Changes in pelvic tilt affect the position of the acetabular component. With increasing posterior pelvic tilt, there is a concomitant increase in acetabular anteversion and inclination. By contrast, an increase in anterior pelvic tilt will result in loss of acetabular anteversion and decrease inclination [20]. Each degree of posterior pelvic tilt has been shown to increase anteversion by 0.7 degrees [21,22]. Lazennec et al. have used these findings to focus on the relationship between sagittal balance of the axial skeleton and the ability of the pelvis to move in space to accommodate different postures including seated and standing positions [1]. The ability of the pelvis to adapt to these changes is related to the pelvic incidence which, as mentioned, is determined by sacral slope and pelvic tilt. Generally speaking, high pelvic incidence is associated with elevated sacral slope angles and increased lumbar lordosis. Pelvises which demonstrate these characteristics can generally accommodate larger changes in sagittal balance. In contrast, those with lower pelvic incidence and or those with fixed lumbopelvic spinal segments (from degeneration or fusion) are less able to adapt to such changes. In this case, spinopelvic accomodation was compromised secondary to fusion, leading to posterior hip instability.

As referenced in Figure 6a [1], pelvic incidence is a patient specific parameter that contributes to lumbar lordosis and three dimensional pelvic orientation. It is determined by pelvic tilt (angle subtended by a vertical line to the center of the sacral end plate and a line to the center of the femoral head) and sacral slope (angle between a horizontal line and a line tangent to the cranial sacral end plate). Acetabular sagittal tilt (angle between a horizontal line and a line tangent to the acetabulum/acetabular component) is thus affected by changes in pelvic tilt and sacral slope. During normal activity in a flexible lumbar spine, pelvic incidence and thus acetabular tilt changes from the sitting to standing position (Figure 6b [1]). In the present case, revision of

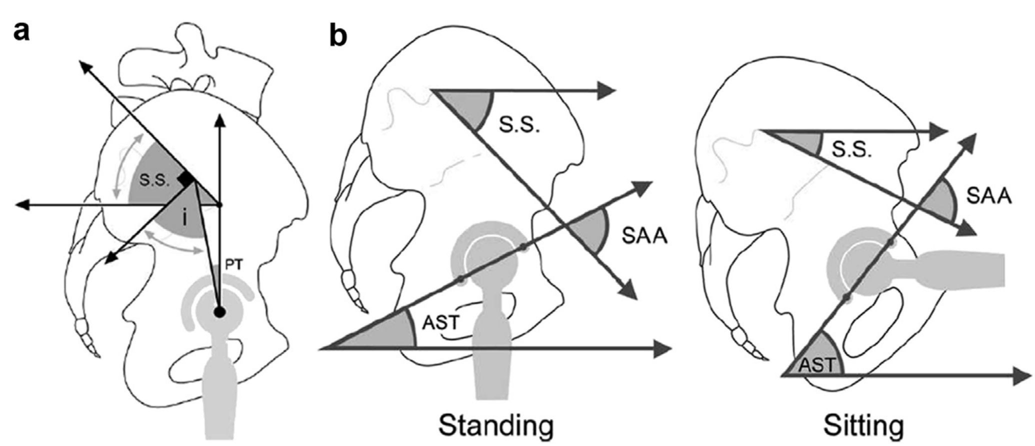

Figure 6. Lateral pelvis drawings demonstrating a) measurements of sacral slope (SS), pelvic incidence (I), and pelvic tilt (PT) and b) change in SS., acetabular saggital tilt (AST) and sacrocetabular angle (SAA) in a patient with a normal lumbar spine as they move from sitting to standing position [1].

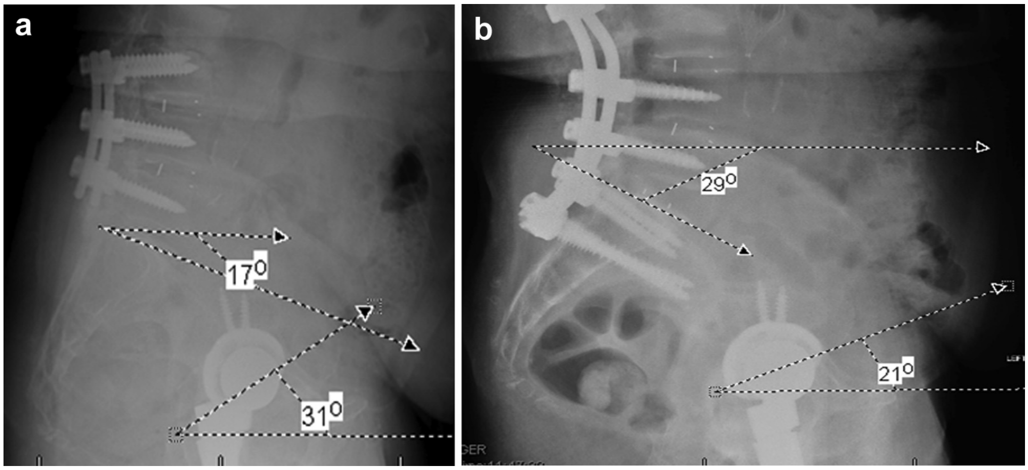

Figure 7. Lateral lumbar spine radiographs a) before and b) after lumbar spine-to-pelvis fusion. These radiographs demonstrate a change in the patients' sacral slope from 17 to 29 degrees and this resulted in a concomitant decrease in her acetabular sagittal tilt from 31 to 21 degrees.

her lumbar fusion from T10-Ilium led to a significant change (increase) in her sagittal balance resulting in a fixed increase in lumbar lordosis. She was noted to have a change in her sacral slope from 17° to 29° resulting in a concomitant decrease in her acetabular sagittal tilt from 31° to 21° (Figure 7a and b). The effect of this increased fixed lumbar lordosis was a resultant relative retroversion of the acetabular socket noted in Figures 5 and 6 that manifested itself as a new onset of recurrent posterior hip instability.

There has been recent focus on refining the way in which we image the pelvis to get a better sense of the dynamic balance of the pelvis and its relationship to the lumbar spine. The EOS system is a 2 dimensional radiograph which allows visualization of the spine and pelvic region simultaneously. It was recently shown to be as reliable as conventional radiography in assessing lumbopelvic parameters with less radiation [23]. In addition, it allows assessment of pelvic adaptation while sitting. In a study by Zhu et al., they showed that up to 15% of patients undergoing primary total hip arthroplasty had greater than 10° of anterior or posterior pelvic tilt which can significantly impact the version and inclination of the pelvis both while sitting and standing [24]. CT imaging has also been used to assess native pelvic and acetabular version and while this provides more precise measurements than plain radiographs, it again is a static image and is taken in the supine position [25]. This does not take into account lumbosacral posture and thus cannot be relied upon alone for accurate assessment of native anteversion. While a standing AP pelvis radiograph is typically used for preoperative planning and may be adequate in many cases, patients with abnormal sagittal balance may require a more comprehensive radiographic evaluation.

Summary

This case highlights the role that sagittal balance plays in pelvic orientation. This patient did very well with components that were placed within the suggested safe zone. However, with a change in sagittal balance resulting in relative retroversion of the acetabular component and elimination of lumbosacral mobility, the potential for instability secondary to impingement was significantly increased. While this was likely unavoidable in this situation where revision spine surgery was deemed necessary, it does call attention to the balance that exists between the lumbar spine the pelvis and highlights the importance of a global perspective when evaluating patients with hip and spine pathology.

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