The Influence of Spinal Deformities on Acetabular Orientation in Total Hip Arthroplasty

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NASS; member, Radiology and Value committee,
SRS; member, Coding and Adult Deformity committee
Background

- The junction between the lumbosacral spine and the pelvis is an important link between the axial and appendicular skeleton.

- Compensatory spine and pelvic dynamics are necessary to maintain balance and range of motion in the native and post-surgical hip.

- Loss of compensation may increase the risk of complication following Total Hip Arthroplasty (THA).
Objectives

• To review the implications of sagittal imbalance and long spinal fusion/deformity on sagittal acetabular orientation during THA.
• A guideline for hip and spine surgeons is provided to aid in decision making for acetabular cup placement or spinal realignment in this subset of patients.

Acetabular Anteversion

• Acetabular anteversion (AA) is used to describe the orientation of the acetabulum within the pelvis.
• Operatively, AA is defined as the angle between the longitudinal axis of the body and the acetabular axis as projected on the sagittal plane.
Acetabular Anteversion

• AA cup placement is suggested to be in the “safe zone” from 5 to 25 degrees of anteversion.
• Studies have shown maximal sagittal arc with hip flexion and extension in this zone.
  – Increased AA increases flexion, decreases extension, and can result in posterior impingement.
  – Decreased AA decreases flexion, increases extension, and can result in anterior impingement.

Spinopelvic Orientation

• Spino-pelvic radiographic parameters have been used to assess balance in sagittal spinal deformities.
  – Pelvic Incidence (PI)
  – Pelvic Tilt (PT)
  – Sacral Slope (SS)
  – PI = PT + SS
• PI is fixed in the adult patient.
• Changes in SS or PT represent compensatory adjustment of the spine and pelvis to maintain balance.
Reciprocal Changes: *Pelvic Compensation*

- Retroversion
- Anteversion

Positional Change

- In patients with a balanced and mobile spine, there is a predictable change in pelvic sagittal alignment.
- With standing, the pelvis flexes forwards (pelvic anteversion) which increases SS and decreases PT
  - In a standing position with hip extension, the pelvis flexes forward (anteverts)
Positional Change

• With sitting, the pelvis extends backwards (pelvic retroversion) which decreases SS and increases PT
  • In a seated position with hip flexion, the pelvis extends backwards (retroverts).
  • With this retroversion (increase in PT), there is an increase in AA as compared to the standing position.

• Patients who have a THA and a balanced spine will show a similar progression in acetabular alignment.

Spinal Imbalance

• With a fixed spinal deformity or a long spinal fusion, the natural dynamic change is limited or lost.
• This can result in potential increased impingement or dislocation with THA, depending on the amount of imbalance and the cup position.
Spinal Imbalance

- Standard cup placement would result in instability if the spinal mal-alignment was greater than 20 degrees (Tang et al).
- In patients with Ankylosing Spondylitis, it is recommended to restore lumbar lordosis prior to THA (Zheng et al).

Guidelines

- THA patients can be categorized by **spinal flexibility and deformity**.
- A history of spine surgery, postural imbalance, or significant spinal degeneration warrants evaluation:
  - Standing lumbosacral radiographs
  - Sitting lumbosacral radiographs
  - (90 degree thigh-trunk angle)
- Pelvic parameters can assess spinal balance:
  - Balanced: PT < 25; PI-LL < 10
  - Unbalanced: PT > 25; PI-LL > 10
Flexible/Balanced
(no prior spinal conditions, fully mobile spino-pelvic junction)

- There is an increase in PT and AA when going to a seated position.
- Due to the compensatory ability of the flexible spine, there is low likelihood of hip impingement with hip flexion and extension at both positions.

Rigid/Balanced
(immobile spine fused or ankylosed in a balanced position)

- In the standing position, there is low likelihood of hip impingement with hip flexion and extension.
- There is no compensatory change when going to a seated position due to fusion; with the lack of increase in AA, there is increased likelihood of anterior hip impingement with maximal hip flexion.
Flexible/Unbalanced
(mobile spine in unbalanced position -- postlaminectomy or neuromuscular kyphosis)

- In the standing position, there may be a compensatory increase in PT and AA as compared to the Flexible/Balanced spine; there is increased likelihood of posterior hip impingement with maximal hip extension.
- In the seated position, the increased AA replicates the Flexible/Balanced spine.

Rigid/Unbalanced
(immobile spine fused or ankylosed in an unbalanced position)

- In the standing position, there may be a compensatory increase in PT and AA as compared to the Flexible/Balanced spine; there is increased likelihood of posterior hip impingement with maximal hip extension.
- There is no compensatory change when seated due to spinal fusion; in the seated position, the increased AA replicates the Flexible/Balanced spine.
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<th>Balanced</th>
<th>Unbalanced</th>
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<td>Cup anteversion from 5 to 25 degrees (normal safe zone)</td>
<td>Spinal realignment followed by THA</td>
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Case – 55M

- Hx of epilepsy
- Mid-thoracic pain after a seizure
- Feels he leans forward
Vertical Cup Posterior Impingement

T7 VCR
PSF T2-L2
Acetabular Anteversion

- Pre-Op
- Post-Op

AA 50 degrees
AA 35 degrees

Case – 45M

- Hx of Ankylosing Spondylitis
- Prior R THA
- Sagittal Imbalance
- Pain in left hip
- THA vs. PSO?
L3 PSO, T12-S1 PSIF
Acetabular Anteversion

• Pre-Op

[Image 1]

• Post-Op

[Image 2]

AA 45 degrees

AA 30 degrees

Conclusion

• The interaction between the lumbosacral spine and the pelvis influences THA outcome.

• Patients can be divided preoperatively in 4 categories based on spinal flexibility and spinal balance.
  – Flexible/Rigid
  – Balanced/Unbalanced
Conclusion

• Acetabular anteversion should be adjusted during cup placement to maximize range of motion and limit impingement.
• Spinal realignment should be considered for patients with significant imbalance prior to THA to prevent aberrant cup placement.

Thank You

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