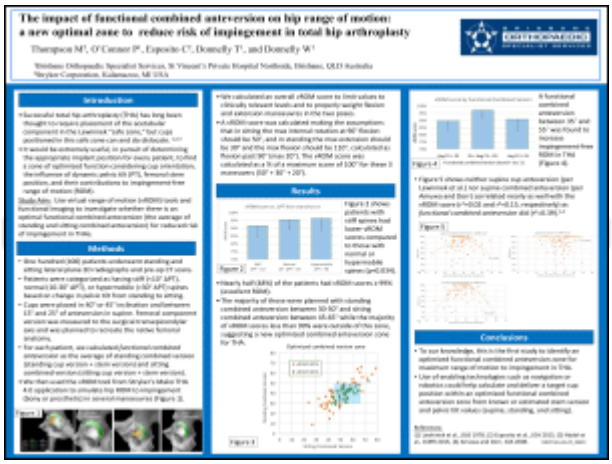
P0019 — 2021 **AAOS**

The Impact of Functional Combined Anteversion on Hip Range-of-Motion: A New Optimal Zone to Reduce Risk of Impingement in Total Hip Arthroplasty

Map (epsMap.cfm?id=19)



Adult Reconstruction Hip Poster Session 1
Presented on Friday, January 8, 2021 7:00 AM

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INTRODUCTION:
Successful total hip arthroplasty (THA) has long been thought to require placement of the acetabular component in a "safe zone" such as the one defined by Lewinnek et al., in order to minimize dislocation after primary THA. However, components positioned in this safe zone can and do dislocate. One possible reason for this may be that supine AP radiographs alone do not account for dynamic changes in pelvic tilt, femoral stem version, or impingement. Even techniques that do incorporate combined anteversion (cup + stem) such as those described by Amuwa and Dorr do not account for the dynamic changes in pelvic tilt.
To optimize THA component position, an algorithm should consider acetabular cup orientation, the influence of dynamic pelvic tilt, femoral stem position, and their contributions to impingement free range-of-motion (ROM). It would be extremely useful, in pursuit of determining the ideal implant position for every patient, to find a functional impingement-free zone taking into account all of these variables. Therefore, in this study we used a virtual hip ROM tool and functional imaging (supine computed tomography (CT) scans, standing and sitting lateral radiographs) to investigate whether there is an ideal functional combined anteversion (the average of standing and sitting combined anteversion) for reduced risk of impingement in THAs.
METHODS:
One-hundred patients underwent standing and sitting head-to-toe biplanar radiographs and CT scans prior to THA surgery. Implants were positioned as deemed appropriate by the surgeon. Supine cup position for all patients were placed in 40° or 45° inclination and between 15° and 25° degrees of anteversion. Femoral component anteversion was documented.
Following surgery, a virtual ROM (vROM) tool was used to reconstruct the preoperative CT scans and the planned implant positions for simulation. Pelvic parameters, including pelvic tilt and sacral slope, were inputted from preoperative standing and sitting radiographs and used to align the pelvis in the vROM tool to calculate functional acetabular anteversion in standing and sitting poses. For each patient, we calculated functional combined anteversion as the average of standing combined version (standing cup anteversion + stem version) and sitting combined version (sitting cup anteversion + stem version). We then simulated hip ROM to impingement (whether bony or prosthetic) in several maneuvers and calculated an overall vROM score to limit values to clinically relevant levels and to properly weight flexion and extension maneuvers in the two poses. The vROM score was calculated making the assumptions that in sitting the max internal rotation at 90° flexion should be 50°, and in standing the max extension should be 30° and the max flexion should be 110°, calculated as flexion past 90 (max 20°) to equally weight standing and sitting. As a result, the vROM score was calculated as a % of a maximum score of 100° for these 3

maneuvers (50° + 30° + 20°).

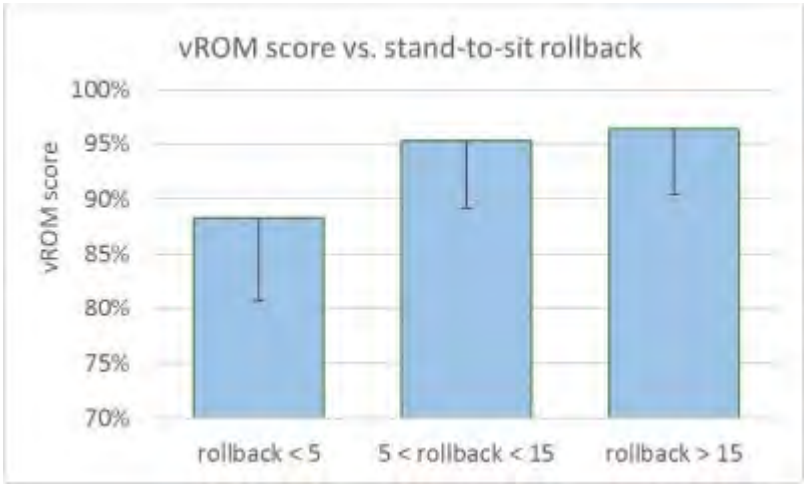
RESULTS:

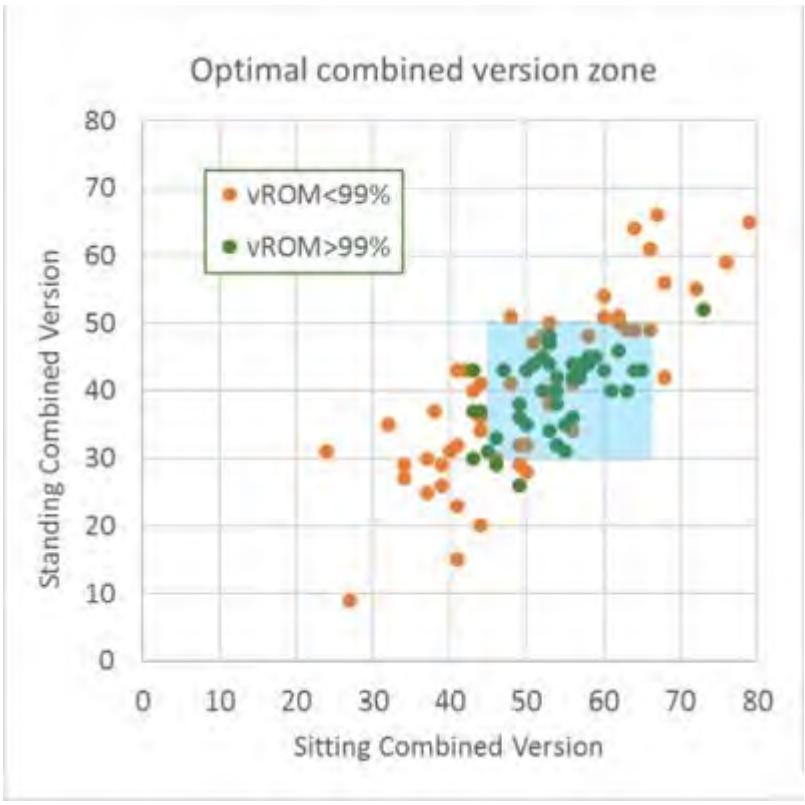
Patients who had minimal posterior pelvic rollback (or rolled forward) from standing to sitting positions had decreased hip ROM (Fig. 1). Nearly half of the patients had vROM scores ≥ 99% (excellent ROM). The vast majority of those were planned with standing combined anteversion between 30-50° and sitting combined anteversion between 45-65° while the majority of vROM scores less than 99% were outside of this zone, suggesting a new optimal combined anteversion zone for THA (Fig. 2).

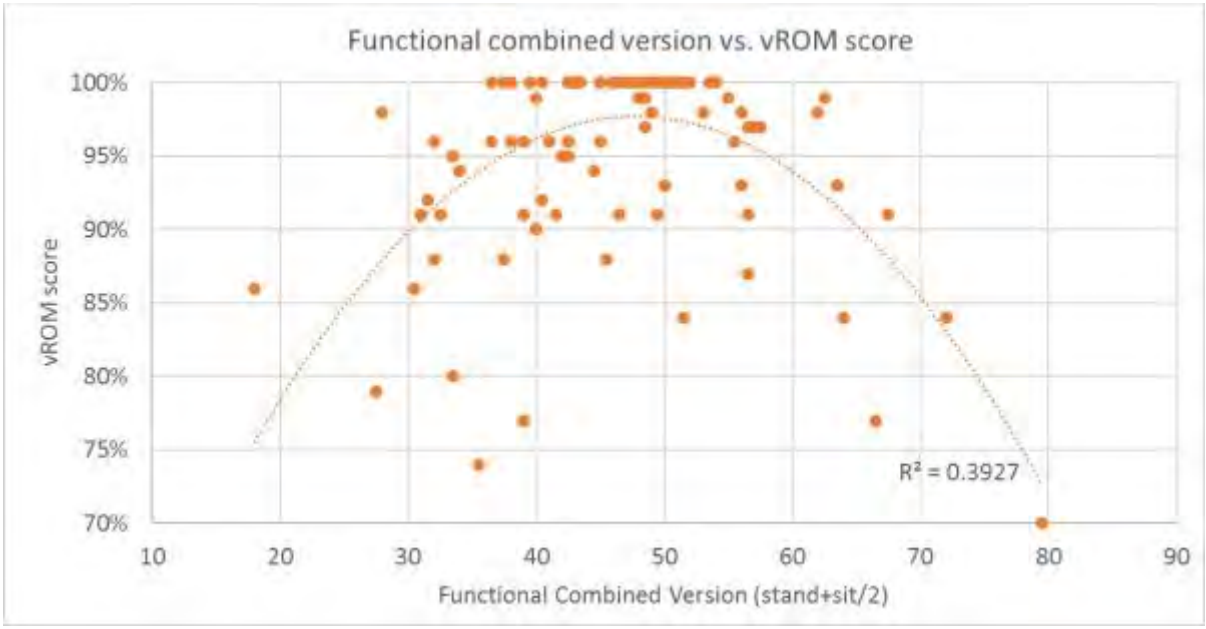
We found a parabolic correlation between functional combined anteversion and vROM score (Fig. 3) suggesting that a functional combined version between 35 and 55 degrees is ideal for maximizing hip ROM (Fig. 4). Neither anatomic supine cup anteversion (per Lewinnek) nor supine combined anteversion (per Amuwa and Dorr) correlated nearly as well with the vROM score (r2=0.02 and r2=0.15, respectively) as functional combined anteversion did (r2=0.39).

DISCUSSION AND CONCLUSION:

Use of enabling technologies such as navigation or robotics could incorporate calculating and execution of the target cup position to hit an optimal functional combined anteversion zone, with known or estimated stem version and pelvic tilt values (supine, standing, and sitting). A target supine cup version can be easily calculated that will optimize range of motion in the more functional poses of standing and sitting. For example, target supine cup version = target functional combined version - stem version - 0.8* (standing tilt + sitting tilt – 2*supine tilt)/2, where 0.8 represents the posterior pelvic tilt-to-anteversion conversion in this example. To our knowledge, this is the first study to identify an optimal functional combined anteversion zone for maximum range of motion to impingement in THA.







Disclosure: M. Thompson: Submitted on: 06/16/2020|Stryker: Employee; Stock or stock Options|; **P. O'Connor:** None; Submitted on: 06/30/2020; **C. Esposito:** Submitted on: 06/29/2020|Stryker: Employee|; **T. Donnelly:** Submitted on: 07/01/2020|Journal of Bone and Joint Surgery - British: Editorial or governing board|Stryker: Unpaid consultant|; **W. Donnelly:** Submitted on: 06/28/2020|Stryker: Unpaid consultant|;
