

Assessment of a Web-Based Tool for Precision Measurement of Acetabular Component Orientation in Total Hip Arthroplasty



Christine Yoon, BS, Anna Eligulashvili, BS, Barlas Goker, MD, Eli Kamara, MD, Edward Mardakhaev, MD
Albert Einstein College of Medicine, Montefiore Medical Center



PURPOSE

Hip dislocation after total hip arthroplasty (THA) can be linked to the orientation of acetabular component placement, characterized by acetabular inclination and anteversion angles obtained from pelvic radiographs. We introduce a novel web tool to streamline the subjective and lengthy process of manual measurement. This tool assists in collecting data that will be used to train an AI model for automation.

BACKGROUND

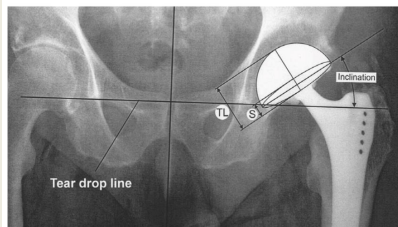
The acetabular (inclination) angle is between the longitudinal axis and acetabular axis, projected onto the coronal plane. The anteversion angle is between the acetabular axis and coronal plane. Each measure has a "safe zone" of angles considered optimal for reducing the risk of postoperative complications such as dislocation (acetabular: 30-50 degrees, anteversion: 5-25 degrees).

Acetabular angle can be measured directly from the intraoperative radiograph (between the line connecting the two pelvic teardrops and opening of the acetabular component), while anteversion angle requires a more complex formula (Fig. 1), including short axis ("S") and the true length ("TL") of the acetabulum.

Problem: Manual measurements of these angles can be cumbersome.

Solution: A web-based tool for precise and simpler measurement.

Fig. 2: Liaw's formula for anteversion (β)



$$\beta = \tan^{-1}(\tan\{\tan^{-1}[\tan(\sin^{-1}\{(S/TL \text{ ratio}) / [2-(S/TL \text{ ratio})]\})\text{csc}\gamma] + 5.46^\circ \sin\gamma$$

METHODS

- One board-certified orthopedic surgeon annotated AP radiographs of 80 patients who underwent unilateral hip arthroplasty from 1/12/2017 to 12/18/2017.
- Manual and web tool measurements included abduction angle (degrees), S/TL ratio, and Liaw's anteversion angle (degrees). Web tool steps shown in Fig. 2.
- Differences between manual and web tool measurements were compared using a paired t-test. P<0.05 was considered statistically significant.

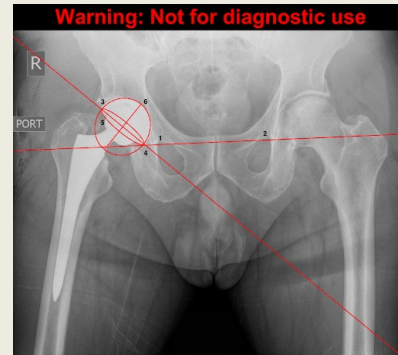


Fig. 2: After uploading an image, the user can click 6 points to determine acetabular and anteversion angles:

- 1 & 2: The user clicks either end of the pelvic teardrop to connect the teardrop line.
- 3 & 4: The user clicks either end of the acetabular cup diameter to determine the acetabular axis.
- 5: The user clicks any point around the acetabular cup to draw the ellipse around the acetabular cup, from which the short axis ("S") is calculated.
- 6: The user clicks any point around the acetabular head to draw its ellipse, from which true length ("TL") is calculated.

RESULTS

Measurement	Manual	Web Tool	p-value
Abduction angle	43.59 ± 5.97	42.82 ± 5.49	0.251
Anteversion angle	20.75 ± 7.81	22.80 ± 10.79	0.080
S/TL ratio	0.43 ± 0.15	0.44 ± 0.16	0.456

There were no statistically significant differences in abduction angle, anteversion angle, and S/TL ratio between annotated and web tool measurements.

DISCUSSION

Advantages: Users are able to obtain results quickly (< 10 seconds per radiograph) and efficiently, with the ability to upload and annotate multiple radiographs at a time, which is especially useful for data collection. Results are also reliable.

Limitations: Small sample size. User must upload the image (rather than annotate directly on imaging software).

CONCLUSION

Preliminary results show the web tool is accurate compared to manual annotation. This tool improves efficiency of angle measurement for intraoperative use and data collection. Future work includes training AI models for automatic angle detection, safe zone determination, and adapting to mobile devices. The web tool may contribute to other areas of radiology where geometry bears relevance to outcomes.

REFERENCES

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TRIAL THE TOOL

<https://bit.ly/hiptool>

