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RESEARCH SYNTHESIS OF RECOMMENDED ACETABULAR CUP ORIENTATIONS FOR TOTAL HIP ARTHROPLASTY

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SUMMARY
Total hip arthroplasty (THA) is regarded as one of the most successful surgical procedures of modern times yet continues to be associated with a small but significant complication rate. Many early failures may be associated with poor component positioning with, in particular, acetabular component orientation dependent on the subjective judgment of the surgeon. In this paper, we compare the manufacturers' instructions on acetabular cup orientation with the Lewinnick recommended "safe zone" [1], by transforming them onto a single, clinically-relevant framework. The limited consensus may reflect an ongoing uncertainty regarding the optimum acetabular component positioning that is potentially responsible for a significant number of hip dislocations and early revisions. Our analysis highlights the need for a surgical reference system which can be used to unambiguously describe the position of the acetabular cup intra-operatively.

INTRODUCTION
Correct positioning of the acetabular cup in THA is vital to ensure success as malpositioning of the acetabular cup increases the risk of revision surgery [2]. As the annual number of THA procedures increases, the number of revision surgeries and the economic burden associated with this will also grow [3].

There is no agreement in the literature as to what the optimum orientation of the acetabular component is [4]. The most widely accepted desired orientation is Lewinnick's definition of a 40° lateral opening angle and 15° anteversion with a safety zone of ± 10° as adherence to these guidelines has been shown to reduce the chance of dislocation [1]. Objective comparisons of published studies are made difficult due to variation in reference systems, surgical techniques and measurement systems. Murray [5] defined 3 different orientations of inclination and anteversion: the radiographic, anatomical and operative reference systems; with conversion equations to allow for comparison between different guidelines. Yoon et al. [6] used this method to compare some of the current recommendations from literature and converted these definitions into a global system however there is no comparison of manufacturers' instructions and the impact this has on current surgical technique. Therefore the aim of this research synthesis is to compare the planned orientation of the acetabular cup, as per the manufacturers' instructions, to the Lewinnick definition to highlight any potential disparities and, more importantly, to identify a common consensus of best practice.

METHODS
The National Joint Registry was used to identify the most commonly used implants, the surgical guidelines for which were subsequently selected for inclusion in the analysis [7-14]. All orientations were transformed [5] to the operative reference frame and compared to the Lewinnick safe zone.

RESULTS AND DISCUSSION
Compilation of the different recommended orientations of the acetabular cup as per the manufacturers' instructions, showed a variety of orientations using different terms, reference and measurement systems.

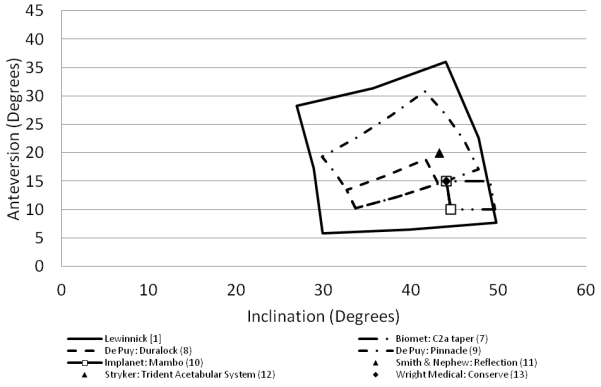

Figure 1: Recommended Orientations of the Acetabular Cup

Figure 1 details the manufacturers' recommended orientation of the acetabular cup in the operative reference system with respect to the Lewinnick recommended "safe zone". The majority of manufacturers describe the inclination angle using the radiographic definition and the anteversion angle using the operative definition, with the exception of DePuy who use the anatomical definition. Results show that the suggested operative inclination angle range is between 29.8° - 49.6° and operative anteversion angle range is between 10° – 30.8°. The results show that

the majority of manufacturers recommend placing the acetabular cup at an inclination angle of 45° but the recommended anteversion angle is more variable with most around 15 – 20°. 87.5% of the surgical guidelines are fully contained within the recommended Lewinnick "safe zone" however, 75% are concentrated in the bottom right quadrant. This may put a surgeon in a quandary, as aiming for the middle of the safe zone may contradict manufacturers' guidelines. Furthermore, aiming at a manufacturer's guideline risks, given inherent surgical variability, the cup being positioned outside of Lewinnick's safe zone.

One of the most critical factors under the surgeon's control is the position of the acetabular cup [15] therefore it is vital that the surgeon has accurate and precise control over the position of the implanted acetabular cup [16]. Variability in methods, guidelines and recommended orientations has resulted in a lack of a standardised measurement method or agreed orientation [6]. Converting all manufacturers' suggested guidelines into the operative reference system has enabled direct comparisons to be made.

Current mechanical guides require the surgeon to have precise control of two planes at once as the inclination and anteversion angles are measured separately. Therefore the position indicated intra-operatively by the mechanical guide displays the inclination angle on the coronal plane and the anteversion angle in the sagittal plane. The results demonstrate a limitation with the use of Murray's definitions and suggest the need for a fourth. Using Murray's [5] definitions, mechanical guides show a radiographic inclination angle and an operative anteversion angle. Most of the manufacturer's safety guidelines use this combination to define the suggested acetabular cup orientation. To overcome this discrepancy we suggest this combination should be referred to as the surgical reference system.

Although most of the manufacturer's use this surgical reference system, and this is used during the operation, Lewinnick's safe zone is based on measurements taken post-operatively on radiographs, i.e. in the radiographic orientation. Using the surgical definition intra-operatively and a radiographic definition postoperatively can lead to further discrepancy and confusion during evaluation. Further concerns are that the operative reference system relies on the patient being in a perfect lateral decubitus position and, radiographically, any rotation of the pelvis can add error [19]. Finally, pelvic tilt is also a major factor in acetabular orientation and is also uncontrolled in THA [20-22].

CONCLUSIONS

There is no consensus in the optimum orientation of the acetabular component in THA. Ensuring that all literature and guidelines are in the same definition would, at least, allow direct comparison to be made between the current approaches enabling further research to relate outcomes to cup position. This could lead to a reduction in the variability of recommended positions and improved surgical outcomes.

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