Preliminary evaluation of the Periacetabular region density relationship with iliac crest and pubic rami BMD

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INTRODUCTION: Total hip arthroplasty is an effective and cost-efficient orthopedic surgical procedure that is aimed at reconstructing the acetabulofemoral joint to improve function in patients with hip related pathologies. (Varacallo et al., 2025) Hip related pathologies that warrant for an invasive reconstruction of the acetabulofemoral joint include avascular necrosis, primary osteoarthritis, inflammatory arthritis and trauma. (Kumar et al., 2020) In 2022 the American Joint Replacement registry reported that 2,550,532 joint replacement surgeries were performed with 37.3% being primary THAs (Hegde et al., 2023) and there is a increasing demand in years to come. (Jones et al., 2025) It is predicted that by 2030, an estimated 572,000 THAs will be performed with 28% of those candidates being under the age of 55. (Cieremans et al., 2023) In order to prevent any errors during or after the surgical process, perioperative planning is implemented in which radiographic reviews are performed to assess sizing, identifying landmarks along the joint, and positioning the prosthetic especially in osteoporotic acetabular joints. (Colombi et al., 2019) As part of perioperative planning, surgeons use radiographic imaging and templating to predict the positioning of the prosthetic in line with the press-fit principle for cup fixation. (Widmer et al., 2002) Moreover, techniques such as CT, which provide information on bone quality with a differentiation between cancellous and cortical bone, and DEXA, which is used to determine the bone mineral density especially for patients with osteoporosis, both help to determine the host bone suitability for press-fit implants. (Ammar et al., 2024; Huppertz et al., 2014) For this purpose, it has been proposed to use of the superior and inferior pubic ramus and the iliac crest (Boyde et al., 1995; Mohseni et al., 2022) Therefore, in this study we aim to identify the level of correlation between the volumetric bone density (VBD) of the periacetabular region and the values extracted from the iliac crest, superior and inferior pubic rami. We hypothesized that a correlations exist between these regions.

METHODS: Nine cadaveric pelvises with age of 78 ± 9 years old were CT scanned using a GE Lightscribe at 120 mA and 100 kV with voxel size of 0.724 and then reconstructed using the program 3D slicer. The obtained geometries were later exported in Rhinoceros 3d (Robert McNeel & Associates, Seattle, WA) in which a custom made grasshopper script was used to identify the ROIs object of study. VBD measures were taken for the iliac superior spine through the intersection of the reconstructed pelvis with a sphere in radius of 19 mm centered in the iliac superior spine while the ramus densities were taken with the intersection of the pelvis with two parallelepipeds containing superior and inferior pubic ramus, respectively. These values were compared and correlated to the ROIs of the periacetabular region using a 2 mm thick hollow spheres centered on the acetabulum. Statistical comparisons between ROIs were conducted using paired T-tests or the corresponding non-parametric Wilcoxon signed-rank test, while inter-ROI density correlations across the acetabular wall, pubic rami, and anterior iliac spine regions were quantified using the Pearson's correlation coefficient; all analyses were done in R with a significance level of 0.05.

RESULTS: All the VBD values of the regions considered were found normally distributed ($p>0.05$) The periacetabular VBD ranged from 119 mg/cc to 386 mg/cc with average of 254±80 mg/cc (see Figure 2). The inferior pubic ramus VBD values exhibited an average of 230±53 mg/cc and a correlation $r=0.28$ with the periacetabular VBD and while the T-test revealed no differences ($p=0.47$) such comparison was found underpowered (Cohen's $d = 0.34$). The comparison of the periacetabular values with the superior pubic ramus that was characterized by an average VBD of 200±49 ($p=0.07$) resulted in greater power (Cohen's $d =0.69$) but in a correlation $r=0.35$. Slightly higher correlation was found with the values of the iliac crest ($r= 0.42$, $p=0.26$) but the comparison was also characterized by low power (Cohen's $d = 0.20$). In some hemipelvises, where the iliac crest VBDs were above 140 mg/cc, there was a statistically significant linear relationship with the periacetabular region vBMDs, with an R^2 of 0.790 ($p<0.01$).

DISCUSSION: While the comparisons here proposed were characterized by low power as in many preliminary studies, the data revealed that for certain subjects the iliac crest at a VBDs above 140 mg/cc has the potential to represent the periacetabular density. This finding encourages a deeper investigation with larger sample sizes on this particular ROIs. It is important to note that the cutoff for osteopenia is 120 mg/cc which could have affected results in some samples. Additionally, there were limitations within the study; the age and number of specimens tested, measures on masks within the programs used, arbitrary regions of interests, lack of CT protocol to locate regions of interests on patients in real-time. (Latz et al., 2022; Ramesh et al., 2023)

SIGNIFICANCE/CLINICAL RELEVANCE: Given that there was found a relationship of the iliac crest with the periacetabular region VBD above 140 mg/cc, future studies with larger sample sizes should be performed to deeply investigate the diagnostic potential of this site in providing a characterization of the periacetabular bone useful at time of surgical planning.

IMAGES AND TABLES:

Figure 1: ROIs considered

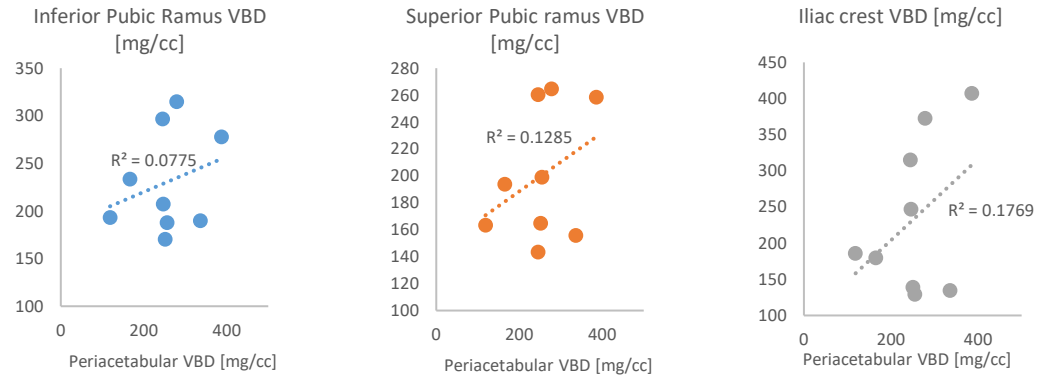

Figure 2: Correlations found for the ROIs considered in this preliminary study