North Asian International Research Journal of Pharmaceutical & Medical Sciences

IRJIF: 5.012

ISSN: 2456-8287 Vol. 6, Issue-5 May-2022

Index Copernicus Value: 55.07 Fulfill MCI Criteria Indian Citation Index

NAIRJC

A Peer Reviewed Refereed Journal

DOI: 10.5859/2456-8287.2022.00005.04

# TRABECULAR BONE STRUCTURE AT THE DISTAL RADIUS

DR. SORNAY-RENDU

## BACKGROUND INFORMATION

The distal end of the radius forms two palpable points, radially the styloid process and Lister's tubercle on the ulnar side. Many studies have been carried out using a variety of methods to evaluate bone strength, mineralisation and architecture. Using skeletal remains to identify degradation of the trabecular bone in both male and female of various ages at death. Previous research in the field of forensic anthropology has shown that regional variation across such sections may be masked through use of a global analysis provides good results but with room to improve as technology becomes increasingly available (Boyd, S. 2015). Sode et al carried out a study that looked at sectioning the distal radius into axial sections and using high resolution peripheral quantitative computed tomography (HR-pQCT) to conclude whether similar results were obtained through global analysis and sectional analysis.

The distal end of the radius forms two physical points, the styloid processs on the radius side and Lister's tuberclee on the ulnar side. A medullary cavity is enclosed in a strong wall of compact bone, which is thickest at the interosseous border and thinnest at the extremities. The trabeculae of the spongy tissue arch at the upper end and pass from the compact layer of the shaft to the articular head. The radius has a body and two extremities. Sectioning the distal radius and taking images that can be analysed, measured and averages taken will provide higher accuracy and minimise artefacts found in other studies.

HR-pQCT is a non-invasive, method for assessing bone microarchitecture and volumetric bone mineral density in cortical and trabecular compartments of the distal radius that has a low radiation risk. Its use in clinical research has increased enormously in recent years and has changed the understanding of age-related changes and sex differences

in bone microarchitecture. Changes in bone structure across a wide range of bone metabolic disorders, fracture risk have also benefitted from this method.

The accessibility of HR-pQCT has made it viable to gage three-dimensional bone microarchitecture and volumetric bone mineral density in vivo, with an accuracy that had yet to be achieved with other methods ( ). Recent studies using this new imaging tool has amplified understanding of age-related changes and sex differences in bone microarchitecture. The use of finite element analysis modelling to non-invasively estimate bone strength and predict fractures using reconstructed three-dimensional images is a great benefit and more suitable than invasive techniques using stronger doses of radiation.

Regional analysis, by dividing the HR-pQCT images of the radius cross-section, provides corresponding information about the core structural diversity of trabecular structure that is coupled with underlying biomechanical conditions. We hypothesize that trabecular bone structure varies spatially across the trabecular compartment at the distal radius, and the degree of differences due to gender and age depend on the region.

Gordon et al suggests the increased sensitivity achieved by their indices suggests that an in vivo assessment of trabecular bone structure can contribute significantly to the identification of persons at risk of fracture in the living (Gordon, C., Webber, C., Adachi, J. and Christoforou, N.2017).

## AIM OF PROPOSED RESEARCH

Regional variation in trabecular structure across axial sections is often obscured by the conventional global analysis, which takes an average value for the entire trabecular compartment. The objective of this study is to use in vivo HR-pQCT to investigate regional variations in trabecular structure at the distal radius and its differences due to gender and age.

## HYPOTHESIS

As age progression occurs, the bone volume fraction in trabecular bone of the distal radius will decrease as age increases. The null hypothesis concur that the bone volume fraction will show no change as age increases.

## RECRUITMENT

Access to a large, modern, well documented bone collection is available. Provenance, age, sex and cause of death are known. Radial bones will be sourced from this collection to include individuals ranging from 18 – 78 years of age. Two groups, male and female will be used. Statistical values were calculated and are shown in table 1.

| Confidence Level | Population Size | Proportion | Confidence Interval | Upper | lower | Standard Error | Relative Standard Error | Sample Size |
|---|---|---|---|---|---|---|---|---|
| 95 | 1000 | 0.5 | 0.05 | 0.55 | 0.45 | 0.02551 | 5.1 | 278 |

Table 1: Results of the statistical calculations used on the data set.

An estimation of 278 samples is needed for this study. However, for research to progress, this data and calculation will again be confirmed to ensure the figures are correct for valid results.

## INCLUSION AND EXCLUSION CRITERIA

Bones from the radius will be used from the collection and taken from individuals of both genders aged 18 -78 at time of death. Any specimens indicating pathology will be void from this study.

## ASSUMPTIONS AND PRECAUTIONS

Based on a previous study, carried out by Boyd et al states that HR-pQCT is a non-invasive, low-radiation method for the analysis of bone specimens meaning that very limited exposure will result. Health and safety will be witnessed while using the apparatus necessary to obtain the images. In agreement with guidelines published by the health and safety executive in 2012 the doses of radiation will also be monitored and recorded. Personal protective equipment to include a laboratory coat, gloves and goggles will be worn to prevent contamination or damage to the bone collection. As demonstrated in numerous studies conventional global analysis can obscure regional differences.

## MATERIALS

Equipment required for this study is based on the study using HR-pQCT led by Sode et al (Sode et al., 2008)

- High-resolution peripheral quantitative computed tomography (HR-pQCT)- the XtremeCT
- Image Processing Language (Scanco Medical AG, Brüttisellen, Switzerland)
- Matlab
- Finite element analysis (FEA) modeling

The x-ray source potential was 60 kVp with a current of 900 Î¼A. A two-dimensional detector containing 3072 Ã- 256 CCD elements was used to acquire 750 projections at a 100 ms integration time per projection. The 12.6 mm field of view was reconstructed across a 1536 Ã- 1536 matrix, yielding 82 Î¼m isotropic voxels. The images were

segmented and managed in agreement with the standard patient-style analysis protocol using Image Processing Language (Sode et al., 2008).

## ANALYSIS

The HR-pQCT systems have been thoroughly tested for both accuracy and precision using Î¼CT of ex vivo bone as the gold-standard (Sode et al., 2008). The distal radius of each subject was imaged using an in vivo HR-pQCT scanner. A 10mm section of the radius was imaged on both sides to avoid dominant hand Bias. Acquisition time per image was 3 minutes per scan and images were instantly reviewed for artifacts and repeated if any were detected (Boyd, 2015). 9 images were excluded due to artifacts. A semi-automated edge-defining algorithm was applied to mark areas of cortical bone and the target trabecular bone on the surface. The cortical and trabecular regions were sectioned automatically by the analysis protocol as described in detail by Laib et al (Laib et al,1996). Using MATLAB, the trabecular region was divided into inner and outer sub regions. Additionally, inner and outer trabecular compartments were divided into bony quadrants at each section based on the defined reference line from MATLAB to give 8 sub regions in total.

Statistical analysis was undertaken using a Shapiro-Wilk test to predict the normality of the data. Due to separation and standard deviation of trabecular separation the data was not normally distributed so non-parametric statistical analysis was carried out.

## RECOMMENDATIONS FOR FUTURE WORK

This method of analyzing trabecular bone thickness will be a valuable tool both with cadaveric material and living individuals due to the low radiation risk associated. In terms of research to aid the living many fields could gain invaluable knowledge of the risk of fractures and the development and tracking of disease such as osteoporosis. The repeatability of this study will enable others to repeat with greater sample numbers. However, at present its high cost means HR-pQCT is still a research tool, the high resolution and efficiency of this method exposes advantages over the methods used at present for bone assessment which will in time prove an invaluable clinical tool. In the future, regional differences in age-related changes of trabecular structure at the distal radius should be examined in a longitudinal study using slighlty larger radial cross sections.

## REFERENCES


1. Boutroy, S., Van Rietbergen, B., Sornay-Rendu, E., Munoz, F., Bouxsein, M. and Delmas, P. (2007). Finite Element Analysis Based on In Vivo HR-pQCT Images of the Distal Radius Is Associated with Wrist Fracture in Postmenopausal Women. *Journal of Bone and Mineral Research*, 23(3), pp.392-399.
2. Boyd, S. (2015). High resolution imaging of bones by high-resolution peripheral quantitative computed tomography. *Bone Abstracts*.
3. Clarke, B. (2017). *Normal Bone Anatomy and Physiology*. [online] Clinical journal of the American society of nephrology. Available at: http://cjasn.asnjournals.org/content/3/Supplement_3/S131.full [Accessed 19 Mar. 2017].
4. Dalzell, N., Kaptoge, S., Morris, N., Berthier, A., Koller, B., Braak, L., van Rietbergen, B. and Reeve, J. (2009). Bone micro-architecture and determinants of strength in the radius and tibia: age-related changes in a population-based study of normal adults measured with high-resolution pQCT. *Osteoporosis International*, 20(10), pp.1683-1694.
5. Dixon, A. and Jamieson, E. (1937). *Dixon's manual of human osteology*. 1st ed. Oxford: University Press.
6. GENANT, H. (2006). Advanced Imaging Assessment of Bone Quality. *Annals of the New York Academy of Sciences*, 1068(1), pp.410-428.
7. *Gordon, C., Webber, C., Adachi, J. and Christoforou, N. (2017).* In vivo assessment of trabecular bone structure at the distal radius from high-resolution computed tomography images.