3D Evaluation of the trabecular structure of a rat distal femur

Andres Laib and Markus Burkhart
SCANCO Medical AG
Brüttisellen, Switzerland
www.scanco.ch

Customer need

Getting quantitative analysis of the structure of the distal femur of a small animal like a rat or mouse is nowadays indispensible in pharmaceutical research.

An important requirement is sufficient analysis detail to study the micro architecture of the trabecular bone. This means that a spatial resolution in the order of magnitude of 15 µm must be attainable.

Furthermore, the analysis has to be executed in a consistent and repeatable format in order to obtain statistically meaningful studies of drug effectiveness.

Materials and methods

In order to accommodate the above mentioned requirements, the rat femur was investigated using a SCANCO Medical µCT 40 scanner. The following settings have been applied by means of an easy configurable measuring protocol:
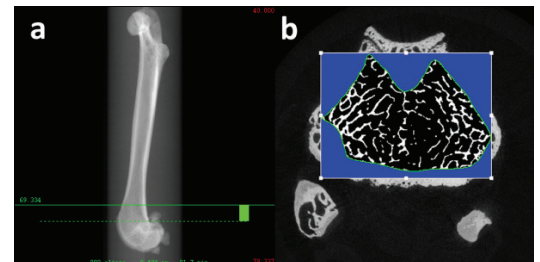-Spatial Resolution: 12 µm
-Beam energy: 70 kVp

Figure 1: a) Easy selection of ROI with Scout View. b) Cross-sectional slice image with free-drawn contour.

-Beam Intensity 114 µA
-Integration Time: 300 ms
-Image Matrix: 1024 x 1024

As can be seen from Fig. 1a the Region of Interest (ROI) was chosen at such a location that the trabecular part of the bone could be investigated optimally. I.e. the lower end of the scan region "touches" the upper end of the condyles, which ensures that the slices will end at the location of the growth plate and still extend into the metaphysis.

Customer need
Quantitative and reproducable analysis of the micro-architecture of trabecular bone.

Materials and methods
SCANCO Medical µCT 40 scanner was used to produce the images and SCANCO evaluation software for segmentation, 3D morphometric analysis and density and distance measurements were used for the analysis.

Results
Qulitative: Visualization of the micro-architecture.
Quantitative: Data sheet including density and volume measurements together with a set of characteristics
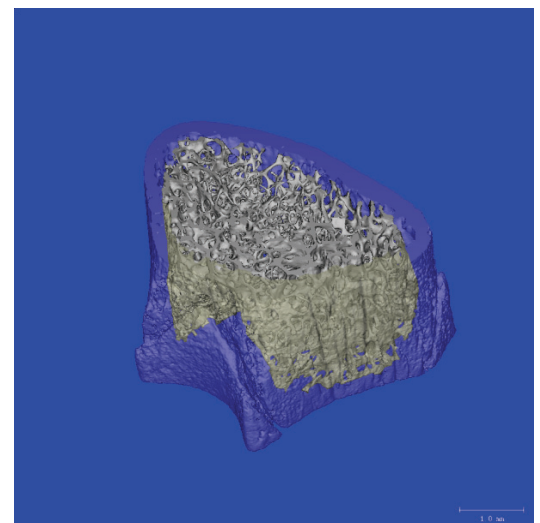

Figure 2: Separation between cortical and trabecular bone is easily done with the standard evaluation scripts in the SCANCO Evaluation Software.

After this ROI has been defined the tomographic scan is being started, with an individual 2D image of each cross-sectional slice as a result.

Fig. 1b shows such a resulting image, together with the hand drawn contour, which defines the region of interest for the evaluation. Such a contour is drawn about every 20th slice. Care is taken that no part of the cortex is included and that the gap between inner cortex and the contour is constant and the same for all samples. Care is also taken that the growth plate is not included in the region of interest.

A separation between the cortical and the trabecular bone can be done for the entire volume using one of the standard scripts included in the SCANCO Evaluation Software, Fig. 2.

Results of the analysis

As can be seen in Fig 3, the structure of the distal femur could be shown qualitatively as well as quantitatively with the desired detail.

The standard evaluation option showing the colour coded local thickness map, proves to be a very valuable tool to visualize the micro architecture.
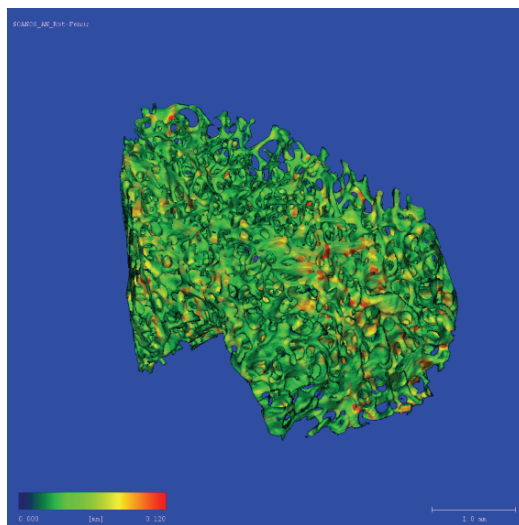

Figure 3: 3D view of the trabecular structure incl. thickness map

Last but not least, figure 4 shows how a quantitative report of the measured structure looks, containing many measurable parameters which characterise the chosen Volume of Interest (VOI). Through this method even small changes between differently treated femurs, can be detected consistently.

Conclusion

Choosing this unique method provided the desired result in a consistent and repeatable manner.

Moreover, next to a qualitative visual presentation, also numerical results are being generated easily.

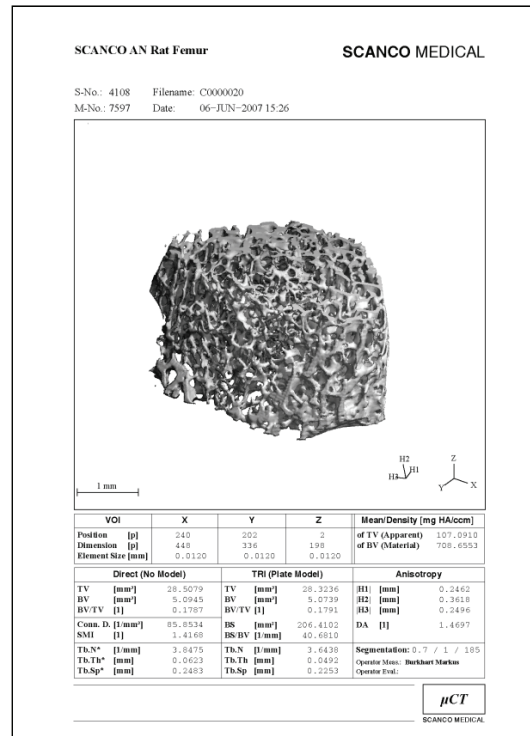This method can be applied to other animal bones, such as vertebra or tibia.

Figure 4: Numerical result sheet.

References
Numerous references to similar studies can be found on the SCANCO Medical webpage: www.scanco.ch

SCANCO equipment
SCANCO Medical µCT 40 scanner

SCANCO software
Measurement program incl. Scout View
Evaluation program
✓   Segmentation
✓   3D morphing
✓   2D/3D morphometric analysis
✓   Density measurement
Visualization program

application note