# Micro-Tomographic Atlas of the Mouse Skeleton

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With 196 Figures

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# Preface

At the present time, the laboratory mouse has become a central tool for skeletal studies, mainly because of the extensive use of genetic manipulations in this species. Naturally, this widespread use of mice in developmental, bone, joint, tooth, and neurological research calls for detailed anatomical knowledge of the mouse skeleton as a reference for experimental design and phenotyping under a variety of experimental conditions, including genetic manipulations (e.g., transgenic and knock-out mice).

Several general treatises on the normal anatomy of the mouse and rat have been published in the previous century. In the absence of adequate technologies, these books describe only the external anatomical features of the different parts of the skeleton. In general, images in these atlases are camera lucida-based line drawings rather than accurate three-dimensional images. Furthermore, so far a systematic two- and three-dimensional description of the internal anatomy of bones, as well as the three-dimensional relationship exhibited in joints, are not available.

Recently, microcomputed tomography (μCT) has emerged as a central tool for the descriptive and quantitative analysis of skeletal anatomy. A publication analysis using PubMed indicates an increase in the number of studies reporting μCT skeletal anatomical surveys from less than ten before 2000 to several hundreds thereafter. Employing up-to-date μCT systems, two- and three-dimensional images of the external and internal skeletal anatomy are attainable at resolutions as high as 6 micrometers. Moreover, morphometric software has been developed for the accurate quantification of anatomical structures such as the cortical and trabecular compartments of bone. Unlike histomorphometry, which in the vast majority of cases is based on a rather small number of sections, μCT morphometry employs a detailed three-dimensional anatomical reconstruction of the whole structural component being investigated. Another major advantage of μCT is its nondestructive nature, namely, skeletal specimens subjected to μCT scanning and morphometric analysis can be further analyzed by complementary histological and biomechanical methods.

In view of the vast employment of genetically manipulated mice and the emergence of μCT as a central tool in bone research, it appears appropriate for the timely publication of a comprehensive reference for skeletal microanatomy. The present treatise is based on skeletal specimens obtained from sexually mature (10-week-old) male C57-Bl/6J mice. This mouse strain was chosen because of its prevalent use for genetic manipulations. The animals were sacrificed by anesthetic overdose and the skeleton surgically stripped of soft tissues, fixed in phosphate-buffered formalin, and then kept in 70% ethanol to avoid decalcification. Scanning in the μCT apparatus (μCT 40, Scanco Medical AG, Bassersdorf, Switzerland) was performed with specimens immersed in 70% ethanol.

The first two parts of the present treatise describe the axial and appendicular skeleton, respectively, with distinct chapters each devoted to a specific bone or group of bones (depending on structural complexity) and their corresponding joints. In general, images of the bones are tri-dimensional, with two-dimensional images or relatively thin three-dimensional slices used to highlight particular microanatomical details such as foramina, canals, and tuberosities. In some cases, these microanatomical details have not been reported previously; consequently, their presence has been confirmed using multiple specimens. Because of the great variations in skeletal anatomy between mouse strains, genders and ages, the third part comprises a comparative morphometric analysis of the femur and a representative lumbar vertebra (L3), the most frequently used experimental skeletal sites. The quantitative data provide reference comparative values separately for the cortical and trabecular compartments as well as average values for these osseous components at the whole femur level.

The emergence of μCT technology has made it possible to generate new, detailed anatomical insights that are more complete than any of the so-far-available anatomical references for lower mammals. The descriptive and quantitative data provided should have value not only for the experimental skeletal biologist but also for a general interpretation of the evolutionary development of the mammalian series.

A couple of new attractive μCT applications have been introduced after completing the manuscript for this book. One is determination of the bone material (mineral) density that for the first time allows accurate spatial assessment of changes in bone calcification. The second is an in-vivo μCT scanner that enables the rapid repeated acquisition of high-resolution images of whole anesthetized animals, thus facilitating longitudinal studies in the same animals as well as a simple approach to the study of blood vessels using conventional contrasting materials.

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