

The Turkey Model: A Novel Animal Model for Arthroscopic Knee Surgery and Associated Study

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INTRODUCTION:

Animal models are vital for developing and testing new treatments for knee injuries. Animals like sheep, pigs, dogs, and rabbits mimic human knee conditions but these animals differ from humans in terms of their quadrupedal anatomy. Arthroscopic knee surgery has been useful for treating knee issues has along with been used in studies with larger animals like dogs, pigs, and sheep. However, these animals are costly to maintain and take longer to mature, affecting research. Turkeys, as bipedal, show promise as a research model due to their size and affordability. This study aims to (1) compare the anatomical, mechanical, and histological properties of the turkey knee to already established models (canines, rabbits) and (2) exploring these properties and testing an arthroscopic procedure.

METHODS: Knee samples were collected from fresh turkeys (n=36, 18 pairs), canines (n=12, 6 pairs), and rabbits (n=12, 6 pairs). All animal knees were obtained from subjects undergoing euthanasia from other IACUC-approved research studies. For anatomical comparison, the size and orientation of the extra and intra-articular structures were measured and compared. All measurements were normalized by the width of the tibial plateau and this normalization process resulted in a ratio known as the Tibial Index. In histology, cross sections and Safranin O-positive tissues were measured. For biomechanical properties, an unconfined compression test was applied to the medial menisci, and the compressive elastic modulus was measured. Regarding arthroscopic surgery on turkey knees, three orthopedic sports medicine surgeons were involved in arthroscopic exploration, caudal cruciate transection, and medial partial meniscectomy of the turkey knee. The procedure duration and the Arthroscopic Surgery Skill Evaluation Tool (ASSET) score was assessed.

RESULTS SECTION: There are three significant differences between turkeys and canines, as well as rabbits: the trochlear is wider and deeper, the orientation of the cruciate ligament is opposite, and the femur is articulated with both the tibia and fibula. However, the medial meniscus has a similar shape, Tibia Index ($p=0.101$ in length, $p=0.247$, 0.066 , and 0.828 in anterior, middle, and posterior width, respectively), and compressive elastic modulus ($p=0.079$) to that of canines and rabbits (**Figure 1**). The safranin O-positive ratio in the medial menisci of turkey ($31.72 \pm 13.59\%$) is also similar to that in canine menisci ($26.86 \pm 17.43\%$) (**Figure 2**). In terms of arthroscopic surgery, the major intra-articular structures of the turkey knee can be explored through arthroscopy (**Figure 3**). Caudal cruciate ligament transection and partial medial meniscectomy can be completed within 30 minutes with progressive improved ASSET score by the three surgeons.

DISCUSSION: Despite certain anatomical distinctions between the turkey knee and the knees of rabbits or dogs, they share a common feature in the medial meniscus. Additionally, the meniscus of turkeys exhibits comparable biomechanical and histological characteristics to those found in canines. Moreover, experienced orthopedic surgeons have the potential to carry out arthroscopic surgery on turkey knees after undergoing a limited number of practice sessions. Some limitations should be addressed. First, the study focuses only on in vitro structural comparison. The healing potential of the menisci and the ability of chondrogenesis have not been investigated. Second, there is no comparison between turkeys and humans, and only data from previous articles were used. Finally, the sample size is small.

SIGNIFICANCE/CLINICAL RELEVANCE: The turkey knee serves as a novel model for animal studies, especially for the medial meniscus, and it also acts as a training model for arthroscopic knee surgery.

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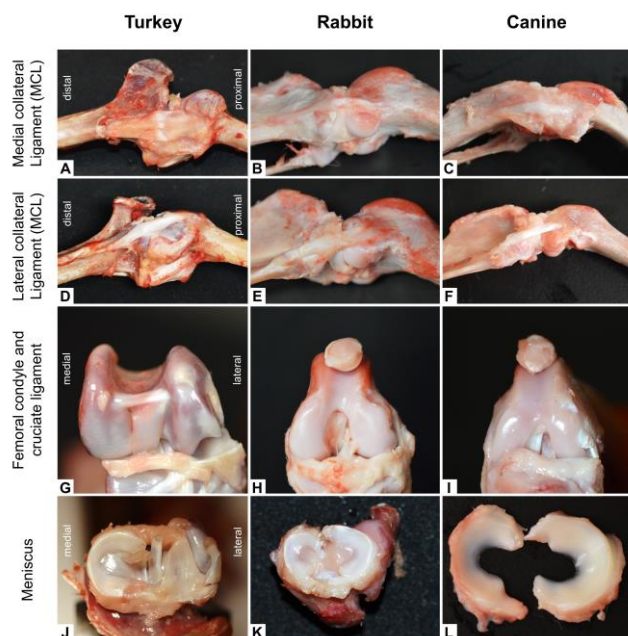


Figure 1. The extra and intra-articular structures of turkey, rabbit and canine

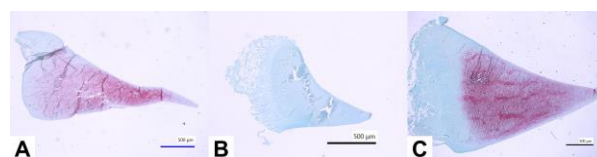


Figure 2. The histology of the medial menisci in turkey (A), rabbit (B) and canine (C).

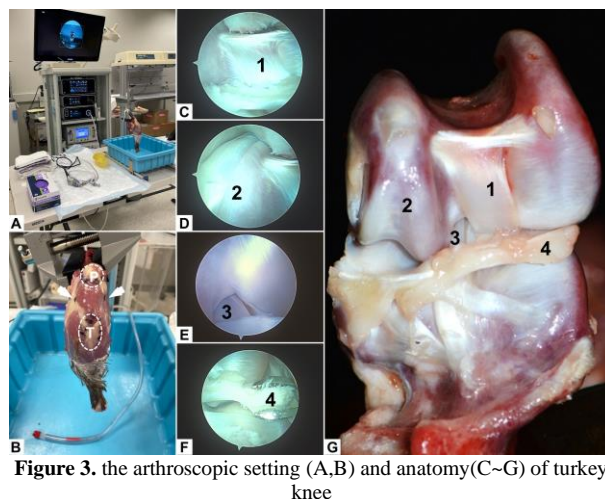


Figure 3. the arthroscopic setting (A,B) and anatomy(C~G) of turkey knee