Bellwether

Applied Engineering in Stifle Repairs

A dog is sent out for a romp and returns limping, one rear leg drawn up. It does not improve over a period of time and the veterinarian diagnoses a torn cruciate ligament. Surgery is performed and within a few weeks the dog is back on all four legs. To the owner the procedure was successful, the dog can run around and the gait appears to be normal. For Gail Smith, V.M.D., Ph.D., this assessment is not enough. The assistant professor of orthopedic surgery at the Veterinary School of the University of Pennsylvania wants to find out whether surgery restored the stifle to maximum stability, ideally to the pre-injury state.

Dr. Smith is currently studying results of different surgical techniques used in cruciate ligament repair to determine which procedure comes closest to restoring the pre-injury conditions. He is conducting quantitative studies where he evaluates the repaired joints and compares them to the uninjured ones. The study is done in conjunction with the Sports Medicine Center at HUP; the measurements and tests are performed at the University of Medicine and Dentistry of New Jersey.

Dr. Smith holds an engineering degree in metallurgy and materials sciences and approaches the stifle joint and its repairs as a problem of loads, stresses, and function of materials. He is not content with exterior evidence and has designed the tests to measure the mechanical stability of the repaired joints. His limited testing has shown that repairs cannot return the stifle to its pre-injury state. “Despite the repairs done, a joint cannot be defined as normal after surgery,” he explained. “The problem is that no material is as finely tuned as the original material, the anterior cruciate ligament. The best we can do at this time is to come close to the pre-injury stability.”

That is a formidable task when one recognizes that the stifle joint presents a complex arrangement of bones, cartilage, ligaments, and muscles, organized in such a manner to permit articulation of the joint whenever the dog walks, runs, jumps, sits, or lies down. It is a masterpiece of construction where forces and counterforces keep the bones from slipping and sliding and permit an accurate, efficient gait.

Each of the many ligaments in the stifle joint has a special function. The two cruciate ligaments are arranged in the interior of the joint, crossing each other, connecting the femur and the tibia. One can think of them as crossed bandings holding the joint together internally, permitting only the hinge action needed for flexing the joint. The two ligaments are strong and composed of precisely arranged bundles of collagen fibers covered by a synovial membrane. The posterior cruciate ligament is not commonly injured; it is the anterior cruciate ligament which bears the brunt of the damage if the joint is used improperly. This occurs if the dog catches its foot, if it is hit sideways, or if it twists its leg with the full weight on the limb, very similar to the classic “football knee.” Then the anterior cruciate ligament may tear, either partially or completely.

(continued on page 7)
He has found that the point of surgical attack of the lateral collateral ligament varies from dog to dog due to the stretch factor of each individual ligament and inherent anatomical variation. The object of the surgery is to obtain maximum tightening of the joint and this is assessed for each individual during surgery. Smith also found that, contrary to earlier opinion, it is important not to remove the meniscus completely but to save or partially excise them and leave them in place because they act as centering devices in the joint. In his studies, Dr. Smith found that this surgery, "fibular head transposition," provides the greatest amount of joint stability when compared to other procedures, because the fibula is moved over by the force of the altered course of the ligament. His measurements show that the "drawer effect," where the tibia can be moved forward, is smaller than after other surgical techniques used to repair the injury.

Because cruciate ligament injury is so common, this is good news to dog owners. Dr. Smith explained that patellar ligament divided into two groups: the young athletic dog which overdoes it or uses the leg in the wrong way, and the older, often overweight dog. In the latter, it appears that the ligament weakness due to degeneration and just gives way. This problem is aggravated by patellar luxation. Dr. Smith feels that dogs which have a luxated patella are predisposed to anterior cruciate ligament rupture and should be considered as surgical candidates for patellar relocation as a preventative measure, especially if middle aged, overweight, and unfit.

The tests Dr. Smith has conducted show that surgery, at the present time, cannot return an injured stifle to its pre-injury stability. Though he has found that by applying engineering principles to the construction and materials of the joint, a close approximation of such stability is possible for the injured dog. The study helps to determine the limits of natural and artificial materials and point the way to better surgical techniques, not only for dogs, but also for people with their four-footed friends, are quite prone to tearing the cruciate ligament.