THE QUEST FOR THE PERFECT KNEE REPLACEMENT

INTRODUCTION:

When the normal knee joint is functioning perfectly, before there has been an injury and before any wear or arthritis has occurred, few stop to appreciate the marvelous engineering of this joint. Typically, no thought is given to the smooth 160 degree arc of motion it provides. Or to the forces of up to 5 times the body weight it supports during simple daily activities such as navigating stairs. Or to the all-day stress to which it is exposed in a physically demanding job. No thought is given to its ability to absorb the peak forces of up to 5 to 10 times the body weight to which it is exposed during the routine athletic movements of sudden starts, stops, jumping, running and twisting. Simply put, when the knee is functioning normally, one never stops to think about the knee at all. It is there: it works.

However, surgeons and engineers responsible for designing and implanting knee replacements for the damaged, worn, and arthritic knee are acutely aware of the intricate engineering of the knee. Trying to match the engineering marvel of the normal knee comprises what has become the holy grail of knee replacement surgery: to develop and implant the “Perfect Knee Replacement”.

THE PERFECT KNEE REPLACEMENT

The perfect knee replacement would be an artificial joint that has full range of motion, would be able to withstand all of the normal forces of daily living and work activity as well as the peak forces of athletic activity. It would be durable and very long lasting. And all the while it would cause no sense of soreness, swelling, or even an awareness that the knee was even there.
THE BARRIERS TO PERFECTION

1. Loss of the Anterior Cruciate Ligament (ACL):
   All total knee replacements, all designs, all manufactures, and all surgeons sacrifice the ACL as a standard part of the procedure. This can produce a sense of play or laxity in the knee. This is mostly compensated for by a combination of design principles inherent in the implants and surgical techniques employed by an experienced knee surgeon.

2. Contractures and Poor Pre-op Range of Motion:
   One of the challenges faced at surgery is overcoming poor pre op range of motion and flexion contractures (inability to fully straighten the knee). Though motion can be improved, the more flexible the knee is prior to surgery, the easier it is to get motion post op. The surgical goal is to obtain 0 – 120 degrees of motion post operatively. Though some patients can get more, others with poor pre op range of motion, contractures, deformity, and prolific pre op scar tissue (often from previous surgical procedures) end with less.

3. Bowed and Knock-Kneed Deformities and Associated Bone Loss:
   Bowed knees typically have bone worn away on the inside of the knee due to the friction of the bone rubbing on bone. Similarly knees with knock-kneed deformity have bone loss on the outside of the knee. Correcting deformities and bone loss adds complexity to the surgical procedure. Femoral and / or tibial bone resection must be of an adequate depth to get beyond the area of bone deficiency.

4. Dealing with Stretched and Contracted (Shortened) Ligaments:
   Bowed knees typically have contracted ligaments on the inside of the knee (Medial Collateral Ligament or MCL) and stretched ligaments on the outside of the knee (Lateral Collateral Ligament or LCL). Knees with knock-kneed deformity have the opposite situation. Here the MCL is stretched and the LCL is contracted. Though there is nothing that can be done to correct stretched ligaments (they cannot be “tightened”), a contracted ligament can be balanced by releasing it at the time of surgery. Though the balance / tautness of the MCL and LCL cannot always be made perfectly symmetrical, it can be dramatically improved.

5. Achieving Symmetrical Ligament Balance in Flexion vs. Extension:
   There is frequently a difference in the tautness of the ligaments with the knee extended (straight) versus when the knee is flexed. Balancing the ligament tension in flexion vs. extension is one of the keys to achieving a knee that feels and functions normally. It involves balancing or substituting for the Posterior Cruciate Ligament (PCL) in the back of the knee so that its tension matches that of the Medial and Lateral Collateral Ligaments.
6. Accommodation of the Soft Tissues to the New Metal - Plastic Knee:
Some patients have swelling in the joint and soreness in the soft tissues as it “rubs” over the metal of the new knee implants. For the most part, this type of soreness and swelling eventually subsides as the body accommodates. In some cases this might take a year or even two for this maturation process to occur.

7. Late Stretching of the Supportive Knee Ligaments:
As noted, the ACL is sacrificed in all Total Knee Replacements. In a small percentage of active patients the remaining ligaments of the knee replacement (MCL, LCL, & PCL) can sometimes stretch making the knee feel “too loose”. This stretching, when it occurs, usually develops within the first year after surgery. If it occurs, there is a relatively simple surgical solution. The plastic insert between the femoral and tibial components can be changed to a thicker one of greater stability to “tighten” the knee.

TKR RESULTS – IF NOT PERFECT, VERY, VERY GOOD:
The barriers to perfection listed above may mean that the knee replacement, no matter how skillfully designed or implanted, can never be as good as the normal knee of youth. Initial soreness just from the surgery itself can last up to a year. It can sometimes take the soft tissues months to accommodate to the new environment of the artificial knee. Occasionally, when excessively stressed, swelling and soreness in the artificial joint can still occur.
However, the results of a precisely performed knee replacement are nonetheless outstanding. The pain and disability of arthritis is completely eliminated. Achieving functional range of motion, if not the range of motion of youth, is expected. Despite the loss of the ACL, ligament stability can be restored so as to be able to withstand the rigors of daily and work activities and most adult recreational athletic activities without restriction. And a well-performed and well cared for knee replacement is quite durable with an expected life span of 15 – 20 years.

CONCLUSION:
It is the goal of the orthopedic manufacturing bioengineering teams to continue improvement of the knee replacement implant design so as to more closely imitate that of the human knee. And it is the goal of the knee surgeon to better understand the barriers to perfection that add complexity to the knee replacement procedure. These include dealing with the loss of the ACL, pre-operative contractures of the joint, bone loss associated with deformities, and the presence of contracted and stretched ligaments. In understanding and dealing with these complexities, we can move ever closer to the goal of “the perfect knee replacement.”