Weight-bearing simulation of imageless navigation-assisted opening wedge high tibial osteotomy

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Introduction: Valgus high tibial osteotomy has been shown to be an effective procedure for the treatment of isolated medial compartment osteoarthritis and osteonecrosis of the knee.[3, 13] In an appropriate indication, the relief of pain and the improvement of function have been well documented to date.[1] The surgical technique of medial opening wedge high tibial osteotomy (MOWHTO) has evolved with technical modifications facilitating correct performance and minimizing complications. The major modifications among them are biplane osteotomy with tibial tuberosity remaining attached to either proximal or distal fragment of tibia. The advantage of performing osteotomy proximal to the tibial tuberosity [17] is the capability of intraoperative fine-tuning in both coronal and sagittal plane correction while osteotomy distal to the tibial tuberosity [11] has its advantage of preventing the change of patellar height.

This study was designed to evaluate the discrepancies between navigation data with weight-bearing and non-weight bearing and postoperative full-leg standing radiographic data.

Methods: Twenty-nine knees underwent biplane opening wedge high tibial osteotomy (OWHTO) for unicompartmental osteoarthritis of the knee using the imageless navigation system. Intraoperatively the non-weight bearing mechanical axis was obtained and also mechanical axis by manual pushing the foot was recorded as well.

Navigation surgeries were performed in all cases. The kinematic and anatomic registration of joint centers and anatomical landmarks were done using imageless navigation system (version 4.2, Orthopilot®, B.Braun Aesculap, Tuttlingen, Germany) after inserting two rigid pins in distal femur and proximal tibia respectively. The simulated weight bearing axis was demonstrated by applying the manual pressure on foot with limb in full extension. This axis was compared with the preoperative standing radiographic data. The mismatch was all within 2˚. Intraoperative data presented on navigation monitor were used as real-time demonstration of correction amount and angle.

The medial tibia was exposed by a 5 cm curvilinear incision two finger breaths medial to tibial tuberosity. Proximal to the pes anserinus, the medial collateral ligament was cut transversely and a blunt Hohmann retractor was inserted to protect the neurovascular structures. The direction of the osteotomy in the frontal plane was marked with a 2.5 mm threaded K-wire under fluoroscopic control. The osteotomy started at the upper margin of the pes anserinus and ended 1 cm from the lateral cortical margin at the level of the tip of the fibula. The osteotomy was performed in a V-shape, in two planes. The first osteotomy was performed distal to the K-wire, parallel to the tibial slope. The second frontal osteotomy plane started in the anterior one-third of the proximal tibia at an angle of 135˚ to the first osteotomy plane. This osteotomy exited the bone proximal to the insertion of the patellar tendon. The osteotomies were performed with the oscillating saw mediodorsally and were completed with chisels. The osteotomy was opened by stepwise insertion of three chisels to avoid intra-articular fractures of the tibial-head fragment. The wedge opening of the osteotomy and the mechanical axis was then adjusted by navigation system according to the preoperative planning using a bone spreader that was inserted into the dorsomedial osteotomy gap. Internal fixation of osteotomy site was done either with spacer plates (B.Braun Aesculap, Tuttlingen, Germany) or Locking Compression Plate System (Tomofix™, Synthes, Solothurn, Switzerland). Appropriate size ChronOS β-TCP (Synthes, Solothurn, Switzerland) was placed in osteotomy wedge site if the opening was more than 7 mm.

Results: Non-weight corrected mechanicial axis was statistically different compared with postoperative full leg standing radiographic data (p=0.039). But, the corrected mechanical axis by manual push was not statistical different with those of postoperative full leg standing radiograph (p=0.181). The correlated factors related these discrepancies were the amount of correction angle and height of patients

Conclusion: Using the imageless navigation-assisted OWHTO is reliable assistant tool for assessment of real-time correction of mechanical axis. But, the system might have the discrepancies correlated with amount of correction angle and length of leg. This discrepancies were originated from non-weight bearing situation intraoperatively. Further evolution of system is needed to have the process of simulation of weight force application.