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Simultaneous anterior cruciate ligament reconstruction and computer-assisted open-wedge high tibial osteotomy: A report of eight cases

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ABSTRACT

Eight patients, aged 37–50 years, with chronic anterior cruciate ligament (ACL) deficiency, medial compartment osteoarthritis and varus deformity underwent simultaneous arthroscopic ACL reconstruction and open-wedge high tibial osteotomy controlled by a computer navigation system.
Despite preoperative planning, the surgeon may need to choose a different osteotomy site during the procedure, invalidating the previous plans. The intraoperative wire control for osteotomies is not precise. The navigation system can help obtain precise alignment during high tibial osteotomy.
The average preoperative mechanical axis was 7.5 of varum (sd ± 1.17°), the average postoperative axis was 1.2° of valgus (sd ± 1.04°) ($p<0.01$), and the average correction of the mechanical axis was 8.7° (sd ± 0.76°). The site of the osteotomy was 3.9 cm (3.5–4.8 cm, sd ± 0.35 mm) from the articular line, with an inclination of 27.9° (24–35, sd ± 4.8). The simultaneous use of these procedures allowed proper correction of the knee axis during the surgery. The surgery can be performed concomitantly with ACL reconstruction.

1. Introduction

Combined medial compartment osteoarthritis and chronic anterior cruciate ligament deficiency (ACL) may require surgical treatment. There are three main surgical options: ACL reconstruction alone, valgus high tibial osteotomy alone and a combined procedure [1,4,7,19,23].

Some patients with chronic ACL deficiency may develop double varus deformity and may require a valgus high tibia osteotomy procedure along with ACL reconstruction [3,15]. Tibial osteotomy plus ACL reconstruction may be performed as two separate procedures or as a combined surgery.

There are three different surgical techniques for high tibial valgus osteotomy: open-wedge medial osteotomy, closed-wedge lateral osteotomy, and dome osteotomy [20].

With the open-wedge osteotomy technique, it is possible to control the correction during the procedure to achieve the proper valgus correction. Usually, surgeons use preoperatively planned data [13] or the intraoperative wire technique to determine the size of the wedge opening. The most frequent goal is to change the mechanical axis to 62.5% of the tibial plateau or to 3° of valgus.

When preoperative planning is used, it is important to make the osteotomy incision at the planned site to maintain the correct relationship between the wedge opening length and the angle correction. During the concomitant ACL reconstruction, the tibial tunnel may interfere with the osteotomy site.

With the development of computer navigation, it is now possible to control the valgus correction intraoperatively [12]. Using navigation control, the influence of changing the osteotomy site on the limb axis correction can be predicted.

We report the cases of eight patients, aged 27 to 46 years old, who underwent simultaneous combined arthroscopic ACL reconstruction and open-wedge high tibial osteotomy (OWHTO) using proper internal fixation.

The main purpose of this study was to describe the technical procedure as a possible surgical treatment to obtain proper correction of the mechanical axis of the limb.

2. Methods

2.1. Patients

Eight patients, aged 27 to 46 years old (average 39.1 and median 40), with instability as their main complaint, were initially treated conservatively. After the failure of conservative therapy, they underwent simultaneous combined arthroscopic ACL reconstruction

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and open-wedge high tibial osteotomy (OWHTO) controlled by computer navigation.

Prior to surgery, all the patients underwent knee MRI, standing knee radiographs, weight bearing inferior limb radiographs and digital limb scout images.

The limb scout images were obtained with a CT scanner in a standard position.

Informed consent was obtained before the preoperative knee image studies and the combined surgery.

After the surgery, standing knee radiographs, weight bearing inferior limb radiographs and digital limb scout images were obtained [8] (Fig. 1).

To determine the degree of varus deformity, represented by the femoral–tibial angle, the images where assessed with PACS (Picture Archiving Communication System, Infinitt, Seoul, South Korea) software. The mechanical axis was calculated by drawing a line from the center of the head of the femur to the center of the knee and another from the center of the knee to the center of the ankle. The acute angle formed by the intersection of the two lines at the center of the knee denotes the mechanical axis.

Fig. 1. Inferior limb radiograph.

2.2. Surgical technique

Each patient was positioned in dorsal decubitus on a radiolucent operation table. A tourniquet was applied to the patient and inflated to 100 mmHg greater than the systolic blood pressure.

At the time of the simultaneous surgery, diagnostic knee arthroscopy was performed, and cartilaginous surface lesions were evaluated according to the recommendations of the International Cartilage Repair Society (ICRS).

The navigation system (Stryker eNlite Knee Navigation System – Stryker, EUA) was a real-time tridimensional imageless computer system. The navigation system was composed of a computer, a camera, trackers, computer software, tracker-to-bone fixation devices and a pointer tracker (Figs. 2 and 3).

The navigation system trackers were drilled and fixed in the distal femur, 10 cm proximal to the superior pole of the patella. The knee was flexed and extended many times to ensure that the trackers were well fixed and that the quadriceps muscle was able to move freely. Another tracker was fixed in the tibia, 15 cm distal to the articular line.

With the arthroscopic view, the intra-articular reference points were uploaded to the computer system. We used a central patellar tendon auxiliary portal and a central quadriceps tendon portal to upload all of the points to the computer (femur center, tibia center, femoral axis, and tibial axis). The femoral head center was obtained with hip rotational and flexion movements. The ankle points were obtained with the pointer.

An approximately 8-cm longitudinal skin incision was made along the medial side of the patellar tendon, and the semitendinosus and gracilis tendons were harvested for the four-strand hamstring autograft.

The line of the osteotomy was drawn at a position 30 mm distal to the tibial joint line. Before the osteotomy incision was made, the incision site was checked with an ACL tibial guide to confirm that the tibial tunnel was feasible despite the osteotomy. If necessary, the osteotomy site was changed.

Under fluoroscopy, the osteotomy incision was made and then gradually opened. The correction was controlled with the navigation system. We corrected the osteotomy to one, two or three degrees of valgus alignment depending on the grade of the medial cartilage compromise (Fig. 4).

To control the tibial slope, we inserted two parallel anterior pins to record the initial and final tibial slopes using the resection plane probe from the navigation system.

The osteotomy was stabilized with an Anthony plate implant (Anthony-K plate — France Bloc S.A., CE n0499, ISO 9001, EN 46001).

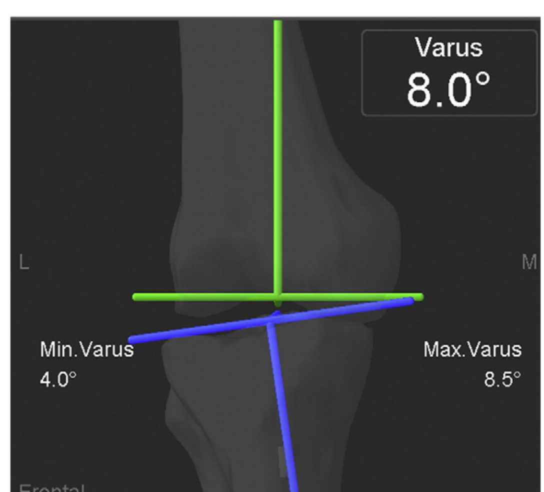

Fig. 2. Inferior limb preoperative mechanical axis in the navigation system screen.