Improvement of Knee Center of Rotation after Open-Wedge High Tibial Osteotomy in Walking

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Disclosures:

Introduction: Knee osteoarthritis (OA) is a common degenerative disease of the joint in old people and there are many surgical treatments such as high tibial osteotomy (HTO) and total knee arthroplasty (TKA). Pain in the OA knee would unconsciously result in abnormal movements during daily activities such as walking, sitting, and standing. It is necessary to understand this kinematic abnormality for diagnosis and treatment of the OA patients. The center of rotation (COR) of the knee is fundamental information to analyze the knee kinematics. Recently, an innovative technique called the optimal common shape technique (OCST) to reduce the influence of individual marker movements and the symmetrical axis of rotation approach (SARA) to calculate the COR throughout the motion analysis timeframes were suggested [1, 2]. In this study, the improvement of knee COR in patients after the open-wedge HTO was estimated in walking.

Methods: Eight subjects (7 females and 1 male, age 58±5 years, weight 71±14 kg, height 160±7 cm) with one-side knee OA who had received the open-wedge HTO were participated in this study with their agreement. The motion capture with sixty reflective markers was performed before and after the surgery during walking using a motion analysis system with ten cameras (Hawk Digital®, Motion Analysis Inc, USA) (Figure 1). Subjects walked in a normal speed of about 1.1 m/s and repeated the cycle. The combined technique of the OCST and the SARA was used to calculate the three dimensional location of instantaneous knee COR, where the combined technique was already validated by a virtual simple knee joint model. The location of estimated COR from the anatomical center of the knee joint in the lateral-medial direction during walking before and after the surgery was compared to that of normal people (laterally 20 mm - 100 mm). In addition, the symmetries between the OA knee and contralateral knee were also investigated to assess the improvement after the surgery.

Results: Before the surgery, the CORs of OA knees were mostly outside or near the normal range, and there are big differences between the OA and contralateral knees (Figure 2). After the surgery, the CORs of both OA and contralateral knees were improved within the normal range in most cases except the subjects 1 and 6. In addition, the discrepancies were quite reduced in most patients after the surgery.

Discussion: The COR was defined as a reference for evaluating the balance between two knee joints in patients who were operated by the HTO surgery. All the patients’ COR locations of both OA and contralateral knee joints were substantially different before surgery, and the COR locations were improved in terms of the lateral locations and/or the symmetry. Most COR locations after the HTO surgery were on the lateral side of the tibial plateau reported in [3, 4] as the COR locations of intact knees were located on the 20 - 100 mm lateral side of knee joint in normal subjects. The video taken in the experiment supported that the patient’s walking pattern is not so natural before the surgery, but it looked similar to normal walking after the surgery. The results indicated that the HTO surgery could restore the COR location during walking, which is an essential information regarding the kinematic analysis. The COR location would be considered as an index to quantitatively evaluate the surgical outcome.

Significance: Because the knee CORs of OA patients during walking were improved after the HTO surgery in terms of location and/or symmetry, it was suggested that the accurate knee COR could be used as an index to assess the surgical outcome.

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Figure 1 Positions of markers attached to the participants’ body and the corresponding model in the motion analysis program.

Figure 2 Comparison between OA knee and normal knee: COR location from mid-point of knee during walking (I=OA knee, C=contralateral knee).

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