Surgical Management and Treatment of the Anterior Cruciate Ligament–Deficient Knee with Malalignment

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KEYWORDS

• ACL deficiency • Varus malalignment • Tibial slope • HTO

KEY POINTS

- Malalignment can increase stress on anterior cruciate ligament (ACL) reconstruction, contributing to recurrent instability.
- Varus malalignment can lead to overload of the medial compartment and symptomatic arthritis.
- Realignment osteotomy can reduce symptoms of ACL instability and unload or reduce mechanical wear of the medial compartment.
- Correction of varus malalignment can improve outcomes of revision ACL reconstruction.
- Changes of tibial slope can affect symptomatic ACL laxity.

INTRODUCTION

In all patients with knee instability, arthritis, or combined instability and arthritis, a thorough evaluation of coronal (varus or valgus) and sagittal alignment (tibial slope) should be performed. Individuals with ligamentous injury compounded by predisposing malalignment have a higher failure rate with soft tissue reconstruction alone. Malalignment can be a cause of recurrent instability following anterior cruciate ligament (ACL) reconstruction. There are 2 common forms of malalignment that can exacerbate instability and arthritis in an ACL-deficient knee: varus malalignment with early medial compartment arthritis and/or meniscal deficiency; or increased posterior tibial slope, which can result in increased anterior tibial translation.

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In the symptomatic ACL-deficient knee with varus malalignment, the degree and nature of malalignment are important to evaluate. Primary varus refers to the tibiofemoral osseous alignment, including any underlying medial meniscal damage and medial tibiofemoral articular cartilage loss. With a potential loss of proprioception and neuromuscular control after ACL injury,[1] this varus malalignment can be exacerbated dynamically. Double varus refers to elongation of the lateral soft tissue restraints, with lateral tibiofemoral compartment separation (lateral condylar liftoff). Triple varus occurs when chronic stress on the posterolateral structures leads to increased external tibial rotation and a hyperextension recurvatum deformity.[2,3] In triple-varus knees, the medial compartment tends to have a posterior medial tibial wear pattern, thought to be caused by a chronic anterior subluxation of the tibia with respect to the femur[4] (**Fig. 1**A). van de Pol and colleagues[5] showed a direct relationship between varus alignment and ACL tension and suggested that malalignment may lead to ACL reconstruction failure (**Fig. 2**).

Excess posterior tibial slope can also contribute to knee instability in the ACL-deficient knee. Dejour and Bonnin[6] and Giffin and colleagues[7] showed that an increase in tibial slope can lead to increased anterior tibial translation, resulting in symptomatic knee instability (**Fig. 1**B). Rodner and colleagues[8] and Agneskirchner and colleagues[9] studied cartilage and joint kinematics and showed that increasing tibial slope shifts contact pressures to the posterior plateau and a tibial flexion osteotomy can help to redistribute pressure away from the damaged posterior cartilage.

INDICATIONS/CONTRAINDICATIONS

High tibial osteotomy (HTO) is a proven procedure used to redistribute mechanical forces across the knee joint. Indications include knee instability, varus alignment of the knee with associated early medial compartment arthrosis, medial compartment overload following meniscectomy, and osteochondral defects requiring resurfacing

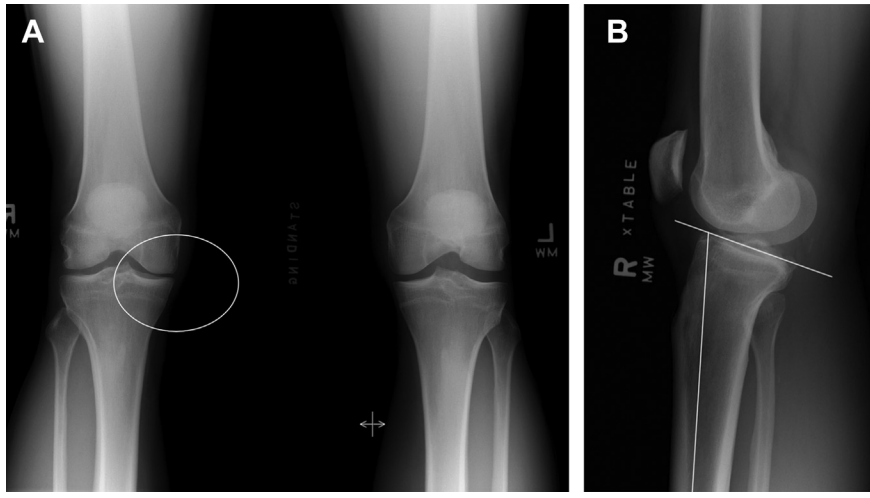

Fig. 1. Patient with symptoms of knee instability and examination findings of ACL laxity, lateral gapping, and varus thrust during gait. Anteroposterior (AP) (*A*) and lateral (*B*) radiographs show varus alignment (*circle in A*) with an increased posterior tibial slope (*B*).