

# Novel Joint Distraction Brace Produces Axial Unloading Force to Manage Tibiofemoral-Compartment OA and Meniscus Injuries

Progression of medial-compartment knee osteoarthritis (OA) is primarily driven by excessive joint forces, leading to progressive cartilage loss and subsequent pain and functional impairment.<sup>1</sup> The loss of cartilage in this compartment results in reduced shock absorption, increased bone-on-bone contact, and heightened pain levels.<sup>2</sup> Meniscus injuries are a common precursor to knee OA, further disrupting knee biomechanics, and amplifying joint stress to initiate or accelerate the progression of OA.<sup>3,4</sup>

## Problem with Traditional OA Unloaders

Medial unloader knee braces are a widely used intervention to address medial compartment OA, which traditionally employ a 3-point valgus force to redistribute load away from the medial compartment.<sup>5</sup> These braces aim to reduce joint forces, however, clinical studies have shown mixed results regarding their efficacy and fail to show clinical significance in pain reduction.<sup>6</sup> The mechanical limitation of the 3-point system is that a small fraction of the force exerted upon the leg translates to the affected joint; discomfort from pressure on the leg can exceed the benefit of pain relief experienced by the patient. This limitation, and variability in numerous published studies, highlight the need for a new mechanical approach to conservative treatment strategies beyond traditional 3-point unloading.

## New Technology: Integrated Joint Distraction

The *Adonis* by Icarus Medical employs a different approach than traditional unloaders by exploiting the benefits of joint distraction, where the brace hinge dynamically expands to axially distract the medial compartment of the wearer's leg. Joint distraction has shown promise in surgical contexts to provide pain relief. Recent innovative, yet invasive devices such as MISHA, KneeReviver, and Dynamic Monotube implants, have shown interesting results in reducing knee OA pain.<sup>9,10</sup> A device by ArthroSave showed promise to reducing and potentially reversing OA symptoms if a joint can be surgically using an external fixator device that is distracted for 6-8 weeks.<sup>7,8</sup>



**Figure 1:** Adonis hinge extends by greater than 1 cm.

## Higher Unloading Force Achieved

The *Adonis* is the first knee brace to integrate joint distraction technology, unlocking potential to a higher unloading force in the tibiofemoral compartment, and is suitable for both the medial, and lateral compartments (this paper focuses on the medial unloader). The force from the distracting hinge is translated to the medial tibiofemoral compartment using geometric wedging and a high-friction silicone interface with the leg. Thigh and calf circumferences increase moving axially away from the knee, allowing the brace to create a wedge that expands as the hinge distracts. The result is a significant, targeted force to unload the medial compartment, while dissipating force over a greater area.

The distraction force is achieved by a patented hinge mechanism, whereby the internal gear radii increase with hinge articulation into knee extension. This brace hinge translates apart greater than 1 cm, which can be seen by the movement of the gear center within the hinge slot (Fig 1). The range of motion for activation was specifically chosen based on the anatomically optimal range for patients, where relevant peak forces are generally observed from 45° to 0° of flexion.<sup>11</sup>



**Figure 2:** (Left) Contact in the medial compartment during flexion. (Right) Joint separation in the medial compartment during extension.

## Distraction Augmented by 3-Point Unloading

The effectiveness of the joint distraction mechanism is augmented by a strapping configuration that pulls the patient into valgus, similar to a traditional 3-point unloader. However, the 3-point pulling force dynamically increases when the brace hinge distracts—increasing the total unloading force. In other words, the cross straps tighten as the hinge extends resulting in a joint distraction force.

## Summary

The new *Adonis* joint distraction system allows for significantly higher joint unloading force by combining a direct, axial joint distraction force with a 3-point unloading force. Initial patients have reported improvements in KOOS Jr. pain and function scores. Additional studies on brace efficacy with pain and function, gait and biomechanical analysis, and patient compliance are underway and will be shared expeditiously.

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