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Commentary

Reply to "Bracing in osteoarthritis": Joint distraction techniques and further application

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To the Editor,

The developments in knee orthotics discussed by Görtz *et al.* [1] well encapsulate the coincident innovation of bracing technology and medical understanding of knee osteoarthritis (OA). The population of OA patients is only increasing, and with it, our understanding of the disease and how best to mitigate its effects. Particularly, the recognition of patellofemoral osteoarthritis (PFOA) as a major contributor to debilitation, and the incorporation of typically invasive joint distraction techniques into bracing emphasize that this conservative treatment modality is making a powerful comeback as a mainstay in long-term OA care. As such, we will further discuss the development of these topics not highlighted in "Bracing in Osteoarthritis" [1].

A New Class of Load Reduction Bracing for PFOA

It is hard to overstate the importance of the patellofemoral joint to overall knee function. As Song *et al.* note, the patella experiences several times a patient's bodyweight during flexion activities because of strain concentration through the patellar and quadriceps tendons [2]. It is no surprise then that PFOA is highly prevalent, and the lack of solutions available for both PF and multi-compartment OA further highlight the in-demand care for a large population of chronically symptomatic patients. Analgesics, nonsteroidal anti-inflammatory drugs, and injections produce varying results depending on the patient. It is difficult to predict which of these treatments will be effective given the multitude of patient-specific factors, drug interactions and lacking definitive evidence for many injection therapies. Clinicians require access to additional effective, conservative solutions that will acknowledge the individuality of each patient, including the presence and severity of cartilage degeneration, and provide rapid relief.

Traditional 3-point unloader braces for tibiofemoral OA address a subset of the population's issue, although the evidence is mixed [3]; patients often report low compliance due to ineffectiveness, discomfort, bulkiness, and displeasing aesthetics. Recent evidence shows that novel load reduction braces, which provide quadricep assistance (or knee extension assistance), may reduce forces within the joint and more effectively alleviate the symptoms of OA, resulting in significant improvements in pain, function, and quality-of-life [3]. Additional research is required to better understand the impact of such load reduction braces on joint biomechanics and osteoarthritis symptoms while developing regimens to apply these devices to address patient specific needs within the continuum of care.

Surgical Joint Distraction in OA Treatment

Current treatments address the biological aspects of osteochondral degradation, which is central to OA progression. However, biomechanical aspects of the disease mechanism are less frequently addressed in conservative care. Joint distraction is an emerging surgical technique, which applies a

biomechanical approach to unload the cartilage and induce biological effects. Recent reviews of existing clinical evidence suggest increases in joint space width following distraction treatment, primarily as a proxy for cartilage thickness [4]. Measurements of net type II collagen synthesis imply that the regenerated cartilage is similarly composed to native articular cartilage, and these results last years after treatment [5]. Unfortunately, these knee distraction methods are invasive, requiring transosseous pins to be inserted into the distal femur and proximal tibia, connected to an external fixation device. Pin site infections around the pins are common, potentially leading to deep infection and even osteomyelitis which may have lasting impacts on the patient's knee and limb health that could negate the benefits of the joint distraction [4]. Distraction procedures typically immobilize the knee at intervals for several weeks, and surgeons slowly incorporate weightbearing activity to prevent the pins from loosening. As Jansen and Mastbergen emphasize, the lack of mechanical stimulation may impact the differentiation of chondrocytes into hyaline chondrocytes that promote hyaline-like matrix synthesis represented in healthy cartilage [4,6]. The restrictive nature of these external devices also prevents full use of the limb for weeks, which may inhibit cartilage synthesis on regions of the knee that are not regularly loaded and contribute to muscle atrophy. Overall, distraction via transosseous pins has a relatively high complication rate, a lack of clinical adoption, and can present other challenges to lower limb health. Joint distraction knee braces have the potential to provide similar ostentive benefits and improve patient outcomes all while remaining decidedly non-invasive.

Joint Distraction Bracing as a Low-Risk Alternative For Cartilage Preservation

Joint distraction bracing represents another novel class of orthopedic bracing, wherein the brace is capable of generating an axial load across the knee joint in combination with a three-point force system to more directly unload the affected knee compartment. Current joint distraction braces, such as those developed by Icarus Medical Innovations (Charlottesville, VA), are enabling clinicians to better tailor their treatments to their patients' needs with application of 3D scanning, CAD design, and additive manufacturing to yield clinically informed, personalized devices. This scan to 3D print approach has demonstrated improvements in patient compliance due to the customized and lightweight nature of the braces [7]. While current invasive joint distraction devices have delayed patients' need for total knee arthroplasty in some cases [4], joint distraction braces present a less resource intensive solution, given their non-invasive nature with fewer requirements for follow-on visits or likelihood of adverse events.

Pre- and Post-Operative Unloader or Joint Distraction Bracing to Accelerate Rehabilitation

Similarly to traditional unloader braces, medial or lateral joint distraction braces can support post-operative or post-injury recovery. In the case of meniscus repairs or cartilage transplants, most rehabilitation protocols suggest partial weightbearing to the affected extremity for six weeks. Intra-articular tibial plateau fractures are also often treated with restricted weightbearing to the affected lower extremity. In this time, significant muscle atrophy and tendon stiffening can occur, increasing the rehab burden and the toll on the patient physically, emotionally, and financially. Joint distraction may enable patients to continue weightbearing on the nonaffected side after injury or operation, accelerating their rehabilitation and potentially return-to-work, duty, or sport. The benefits of this technique could also extend to knee flexion contracture (KFC), which describes the inability to achieve terminal extension of the leg. This often occurs after knee injury and/or surgery, and can be associated with arthrofibrosis. The limitations caused by KFC range in severity and chronicity, but they all contribute to reducing the patient's physical function and ability to complete necessary, daily tasks. It is hypothesized that the torque generated from a joint distraction brace could reduce the risk of developing KFC and/or arthrofibrosis while being implemented in physical therapy to provide passive extension of the limb, and reduce pain responses. More research is needed investigating the efficacy of joint distraction bracing in post-operative and rehabilitation applications.

Conclusion

Bracing is undergoing a renaissance as a viable treatment option for multiple knee conditions, most notably osteoarthritis. From patellofemoral unloader braces to joint distraction mechanisms, bracing addresses OA as a biomechanical challenge, and the technology has demonstrated the ability to convey significant and long-term improvements in pain and function. Future research into the broader implications of novel forms of bracing for conservative management of knee OA and cartilage related injuries is required to understand the impact within the continuum of care. Further exploration may expand access to patients currently within a treatment gap to provide more affordable, effective, low-risk and personalized care.

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