Intrinsic joint tissue repair by joint distraction

K Wiegant1, RJ van Heerwaarden2†, PM van Roermund3†, SC Mastbergen1*

Abstract

Introduction
Joint distraction is a surgical technique that has been used to treat a variety of joint diseases, including degenerative arthropathies such as osteoarthritis and chondrolysis. In this critical review, we described the effect of joint distraction treatment.

Materials and methods
The systematic search was specifically aimed at preclinical and clinical publications about joint distraction in subjects with degenerative cartilage damage. After literature screening, 30 publications were included, reporting on the treatment of degenerative arthropathies of hip, ankle and knee.

Results
Joint distraction has been found to reduce pain and improve joint function in both preclinical and clinical studies. Furthermore, structural tissue repair is shown. Although well documented, the clinical studies are of limited quality. Only two randomized controlled trials, both on ankle joint distraction and both with limited number of patients, were included. Furthermore, most studies have modest follow-up periods of 1 and 2 years.

Conclusion
The results on structural repair induced by this treatment may lead to a better understanding.

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In this critical review, we describe data from pre- and clinical studies on joint distraction, focussing on the larger joints, in relation to tissue repair and clinical benefit.

Materials and methods
For joint distraction, also called arthrodiasis that consists of the Greek words arthro (joint), dia (through) and tasis (to stretch out), a systematic approach was used. PubMed, EMBASE and Cochrane libraries were searched for the words ‘distraction OR arthrodiasis(s) OR joint OR articul’ (December 2012). Titles and abstracts were screened for inclusion and exclusion criteria as formulated in the flow chart (Figure 1). Full text screening designated publications focussing on restoration of degenerative joint damage with temporarily used external fixation devices in animal in vivo and clinical studies. Excluded were analyses without original data, studies in patients with intra-articular fractures or soft-tissue joint contractures, treatments with intraoperative use of distraction without the purpose of tissue regeneration, and treatments with permanent implantation of distraction devices. Screening the reference lists of relevant publications identified additional papers.

Results
Joint repair by joint distraction treatment in preclinical animal models
After screening, seven preclinical animal studies were identified (Table 1). Six of them had the knee as joint target and one study described joint distraction in a spine model.

It must be considered that the animal models described use trauma-induced cartilage (and bone) damage...
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developed in a relatively short time span. This contrasts to the slow onset of joint degeneration (OA) in the human situation.

Remodelling of the damaged joint surface of the knee joint after joint distraction treatment has been demonstrated in three animal studies. In these rabbit models, joint distraction caused joint repair after resection of the entire articular (bone–cartilage) surface of the tibial plateau and in a large osteochondral defect model. Two studies on knee joint distraction demonstrated adverse effects on cartilage integrity, probably influenced by the test models used. Karadam et al. used a model of cartilage chondrocyte death that can be questioned as a representative model of joint degeneration. van Valburg et al. used the anterior cruciate ligament tear dog model that is characterized by permanent joint instability as a trigger for OA and as such not very suitable to allow follow-up. This might explain why in the latter study improvement in structural repair (proteoglycan content) could not be demonstrated, although beneficial changes were seen in chondrocyte activity as measured by proteoglycan synthesis and release.

Changes in cartilage integrity are considered to take time and could be missed without or with short follow-up. This is supported by recently presented interim data on joint distraction applied in the canine Groove model of OA, a model with a single trigger for OA allowing longer follow-up. In comparison with a non-treated OA group, cartilage proteoglycan content and chondrocyte activity were found to show statistically significant improvement together with macroscopically and histologically OARSI cartilage damage score improvements. During follow-up, loading was examined by force plate analysis as surrogate measurement of joint pain and function. OA-related impaired stance and brake forces regained normal levels again after treatment, in comparison with the control group and baseline values. This study supports the idea that structural joint modification and clinical improvement are possible due to joint distraction.

Joint repair by joint distraction treatment in clinical studies

In humans, joint distraction is generally performed in weight-bearing joints, like the ankle, knee and hip, although reports of smaller (nonweight-bearing) joints have been published as well (Figure 2). Most of the time structural repair parameters, such as changes in JSW and bone density, are analysed indirectly with radiography (X-ray), magnetic resonance imaging (MRI) or computed tomography (CT). Clinical parameters as pain and function are measured by the use of questionnaires (e.g. WOMAC or Likert scale).

Hip joint distraction

The first report of joint distraction was treatment of the hip with sev-

eral different causes of joint degeneration (e.g. OA, osteonecrosis and chondrolysis), a hinged frame was applied for 1.5–2.5 months. Pain levels decreased and both function and mobility improved, supported by an increase in JSW on X-ray. Only three adverse events were reported of patients experiencing pain around the pelvic pins. In four patients with inflammatory arthropathy, the results were uniformly disappointing. In 2005 and 2009, two other studies on hip joint distraction were published with only adolescent patients, again showing improvement in pain and function accompanied by increased JSW.

It is remarkable that this quite successful treatment was not further applied in daily clinic. Causes may be
### Table 1 Animal models

<table>
<thead>
<tr>
<th>Joint author, year</th>
<th>Species (age in months); treated; untreated controls</th>
<th>Joint damage model; treatment; duration (weeks); follow-Up (weeks)</th>
<th>Structural outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee van Valburg et al. (2000)&lt;sup&gt;10&lt;/sup&gt;</td>
<td>Beagle dog (13–18); 5 vs. 3; 5</td>
<td>16 weeks ACLT; Hinged ilizarov vs. stiff; 8; —</td>
<td>Less synovial tissue inflammation with distraction. No difference in histological cartilage damage</td>
</tr>
<tr>
<td>Knee Yanai et al. (2005)&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Japanese white rabbit (4–6); 6; 6</td>
<td>Fresh full-thickness cartilage defect; Hinged ilizarov +/- distraction; 12; —</td>
<td>Less regenerated tissue without distraction, within the regenerated area tissue percentage positive coll-type II was higher</td>
</tr>
<tr>
<td>Knee Karadam et al. (2005)&lt;sup&gt;8&lt;/sup&gt;</td>
<td>New Zealand rabbit; 3 × 6; 6</td>
<td>Papain-induced joint degeneration; Hinged vs. stiff; Hinged +/- distraction; 6; —</td>
<td>Increased (ns) cartilage damage scores for all groups, significant for the stiff distraction</td>
</tr>
<tr>
<td>Knee Kajiwara et al. (2005)&lt;sup&gt;7&lt;/sup&gt;</td>
<td>Japanese white rabbit (&gt;6); 3 × 6; —</td>
<td>Fresh osteochondral defect; Hinged custom made; 4-8-12; —</td>
<td>Significant better defect scores at 8 and 12 weeks compared to 4 weeks and control joints</td>
</tr>
<tr>
<td>Knee Nishino et al. (2010)&lt;sup&gt;5&lt;/sup&gt;</td>
<td>Japanese white rabbit (&gt;4); 6 vs. 6; 5</td>
<td>Fresh large articular cartilage defect; Hinged ilizarov +/GWB or CPM; 9 vs. 6 + 3; —</td>
<td>No difference between groups</td>
</tr>
<tr>
<td>Knee Nishino et al. (2010)&lt;sup&gt;6&lt;/sup&gt;</td>
<td>Japanese white rabbit (&gt;4); 9 vs. 7; —</td>
<td>Fresh full-thickness cartilage defect; Hinged ilizarov; 26; none or 26</td>
<td>No difference between groups</td>
</tr>
<tr>
<td>Spine L4–L5 Kroeber et al. (2005)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>New Zealand rabbit; 4 × 6; 6</td>
<td>28 days loading-induced disc degeneration L4–L5; custom dynamic; 1 vs. 4; 4</td>
<td>Within the regenerated area tissue percentage coll-type II was higher with follow-up</td>
</tr>
</tbody>
</table>

The Ilizarov apparatus is a thin wire circular frame fixed or with a hinge. ACLT = anterior cruciate ligament transection. GWB = gradual weight bearing. CPM = continuous passive motion. CT = computed tomography.

The authors declare no conflict of interest. All authors contributed to conception and design, completion of the final manuscript, read and approved the final manuscript. All authors abide by the Association for Medical Ethics (AME) ethical rules of disclosure.

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Addition, the risk of adjacent joint degeneration is prevented. The studies included reported different study designs (case study, retrospective, prospective and randomized controlled trials) and structural parameters evaluated (cartilage growth, subchondral bone density and decrease of bone cysts).

Cartilage growth, defined as a modest15,17,23 to significant16,18,20,26 increase of the JSW on weight-bearing X-rays, is analysed only in 7 out of 12 studies. Unfortunately, not all studies used standardized X-rays leading to potentially biased measurements due to possible differences in positioning during follow-up. Marijissen et al.18 dissolved the bias created by differences in follow-up examinations using standardized X-rays with an aluminium step wedge27. This wedge calibrates for JSW and bone density measurements. In two studies22,26, increase of cartilage tissue in the joint was evaluated with MRI.

Statistically significant and clinically relevant decrease in subchondral bone density, as measured on X-rays, has been demonstrated in three studies19,20,26. In addition to bone density, a decrease of bone cysts on MRI or CT is reported in three separate studies as well22,24,26. These bone changes are particularly interesting, as normalization of subchondral bone 2 years after ankle distraction correlates with a decrease of pain ($R = 0.69, P = 0.002$)24.

In all studies, structural tissue improvements were corroborated with significant clinical improvements in pain and mobility. In three studies, prolonged follow-up after treatment was reported. These studies showed sustained clinical improvement for periods of 5 years20,21 and 10 years19. In the latter, a success rate of 73% was reported for at least 7 years. Adverse events during and following ankle joint distraction were pin-tract infections, reported in six studies, and neuropaxia in 11 patients, three of whom were with persisting complaints15,25.

The literature search revealed 12 clinical studies on ankle joint distraction (Table 2B)15-26. Degenerated ankle joints, more common at an early age (30–40 years of age), are frequently fused with an arthrodesis, being a safe and cost-effective treatment. The application of ankle joint distraction is aimed at joint preservation due to intrinsic joint tissue repair in combination with clinical improvement. In

**Figure 2:** Different techniques of joint distraction in clinical studies.

A12 shows hip joint distraction with the use of a DeBastani frame. B23, C17 show ankle joint distraction with the use of an Ilizarov external fixation frame. D31 shows knee joint distraction with bilateral monotubes (Stryker®) external fixation. E,F28 is a hinged custom-made knee distraction device. G36 shows PIP joint distraction of the finger (hinged compass frame) and H35 shows IP distraction of the thumb (hinged Ilizarov frame). I37 is joint distraction of the metatarsal joint of the foot with a custom-made frame.

Ankle joint distraction

After hip joint distraction, studies on ankle joint distraction were started.

**Table 2A Clinical studies, hip**

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Patient characteristics (number, age (years), disease)</th>
<th>Case report</th>
<th>Retrospective</th>
<th>Prospective</th>
<th>Random contr</th>
<th>Treatment/duration (months); follow-up (years)</th>
<th>Clinical and structural outcomes</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldegheri et al. (1994)</td>
<td>n = 80; (9–69); OA/osteonecrosis/chondrolysis</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pain</td>
<td>Pain in pelvic pins 3/80; 4 arthritis</td>
</tr>
<tr>
<td>Thacker et al. (2005)</td>
<td>n = 11; 13.9 (9–17); Osteonecrosis/idiopathic chondrolysis</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pain</td>
<td>Pin tract infection 1/11; Knee effusion 1/11; Distraction pain 2/11</td>
</tr>
<tr>
<td>Gomez et al. (2009)</td>
<td>n = 28; 14.7 ± 2.5 (9–19); Avascular necrosis</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pain</td>
<td>Pin-tract infections; leg length difference 1/28; additional surgery 12/28</td>
</tr>
</tbody>
</table>

MRI = magnetic resonance imaging. JSW = joint space width.

**Knee joint distraction**

In case of severe knee OA, the most often indicated treatment at present is joint replacement surgery. Due to ageing and the on-going obesity pandemic, both being major predispositions for joint degeneration, there is an exponential increase in knee joint replacement and a high need for strategies that preserve the knee joint. Despite this, only four studies on joint distraction in patients with knee OA have been published to date and are summarized in Table 2C.28–32. In these studies, cartilage regeneration and bone density were measured by X-ray and MRI analysis. Specific analyses for bone cysts were not performed, and most studies were carried out retrospectively (three out of four). Nonetheless, significant increase of JSW on weight-bearing X-rays was demonstrated in all studies.

Only one study21 used standardized X-rays as described above for ankle joint distraction, which allows for digital analysis.21,29 Arthroscopic evaluation and/or MRI evaluation showed cartilage resurfacing and cartilage repair after joint distraction treatment. On MRI, a significant increase in cartilage thickness and volume was seen. In addition to the structural tissue changes, significant improvement in pain and mobility was reported in all studies. In the randomized controlled trial by Aly et al.,32 significant improvement in pain and mobility was demonstrated for the group treated with arthroscopic debridement and knee joint distraction in comparison with arthroscopic debridement treatment alone.

Besides pin-track infections in three studies, other reports on adverse events included one patient with a deep-vein thrombosis22 and three patients with a lung embolism.21,22

Discussion persists on the quality of the newly formed cartilage in the joint. Taking biopsies is argued ethically. Intema et al.31 tried to avoid this by analysing biochemical markers for collagen type II turnover and showed an increase of synthesis over release, suggesting the hyaline nature of the newly formed tissue. Qualitative MRI examinations like dGEMRIC or T1rho have potential added value in determining the quality of newly formed tissue; however, so far this has never been reported in joint distraction studies.

**Other joints**

Besides the larger joints, three clinical studies on treatment of smaller joints were found (Table 2D).35–37 Joint distraction was applied in foot and hand joints.
### Table 2B Clinical studies, ankle

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Subject characteristics: number; age (years); disease</th>
<th>Case report</th>
<th>Retrospective</th>
<th>Prospective</th>
<th>Random control</th>
<th>Treatment; duration (months); follow-up (years)</th>
<th>Clinical and structural outcomes</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>van Valburg et al. (1995)</td>
<td>N = 11; 35 ± 13 (20–70); equine definition of OA</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>Fixed Ilizarov; 1, 5–3 months; 1.7 ± 0.5 (0.8–5) years</td>
<td>Pain + Mobility function ++ X-ray JSW +/-</td>
<td></td>
</tr>
<tr>
<td>Kanbe et al. (1997)</td>
<td>N = 1; 19; chondrolysis</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>Orthofix apparatus; 1 month; 3 years</td>
<td>++ + JSW +/ Fibrocart (+ hist)</td>
<td></td>
</tr>
<tr>
<td>van Valburg et al. (1999)</td>
<td>N = 17; 40 ± 11 (17–55); (post-trauma) OA</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>Fixed Ilizarov; 3 months; 2 years</td>
<td>++ +/- JSW +/-</td>
<td>Pin-tract infection 4/17</td>
</tr>
<tr>
<td>Marijnissen et al. (2002)</td>
<td>N = 57; 44 ± 11 (18–65); (post-trauma) OA</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>(Debridement +/-) Fixed Ilizarov; 3 months; 2.8 ± 0.3 (1–7) years</td>
<td>++ + JSW + BD ++</td>
<td>Pin-tract infection 13/57</td>
</tr>
<tr>
<td>Ploegmakers et al. (2005)</td>
<td>N = 22; 37 ± 11 (19–55); OA</td>
<td>x x</td>
<td></td>
<td></td>
<td></td>
<td>Ilizarov + + Debridement vs. debridement alone; 3 months; 1 year</td>
<td>++ vs. + ++ vs. + JSW + vs. BD + vs. +/-</td>
<td></td>
</tr>
<tr>
<td>Sabharwal et al. (2007)</td>
<td>N = 1; 15; post-trauma chondrolysis</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>Ilizarov; 3 months; 5.5 years</td>
<td>++ + JSW + BD ++</td>
<td></td>
</tr>
<tr>
<td>Paley et al. (2008)</td>
<td>N = 23; 45 (17–62); post-trauma OA</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>Hinged Ilizarov; 4 months; 5.3 (2–13) years</td>
<td>++ + JSW + BD + BC +</td>
<td>Pin-tract infection 2/23</td>
</tr>
<tr>
<td>Lamm et al. (2009)</td>
<td>N = 3; 41; post-trauma arthritis</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>Debridement + hinged Ilizarov; 4 (+1 cast) months; 1 year</td>
<td>JSW + BD + BC +</td>
<td></td>
</tr>
<tr>
<td>Tellisi et al. (2009)</td>
<td>N = 25; 43 (16–73); OA</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>(Debridement +/-) Ilizarov; 3 months; 2.5 (1–5) years</td>
<td>++ + JSW +/-</td>
<td>Pin-tract infection 2/25</td>
</tr>
</tbody>
</table>
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Table 2B (continued)

<table>
<thead>
<tr>
<th>Author et al. (2012)\textsuperscript{a}\textsuperscript{b}</th>
<th>N = 26; 41 ± 9; post-trauma OA</th>
<th>x</th>
<th>Ilizarov fixed + hinged; 3 months; 2 years</th>
<th>++</th>
<th>++</th>
<th>BD ++</th>
<th>BC ++</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salzman et al. (2012)\textsuperscript{c}</td>
<td>N = 36 (18 vs. 18); 42 (18–53) vs. 43 (27–59); post-trauma OA</td>
<td>x</td>
<td>Ilizarov fixed vs. hinged; 3 months; 2 years</td>
<td>+ vs. ++</td>
<td>+ vs. ++</td>
<td>Pin-tract infect + 2 (8) neuropraxia; 3/18 vs. 1/18</td>
<td></td>
</tr>
<tr>
<td>Van Meegeren et al. (2012)\textsuperscript{d}</td>
<td>N = 3; (18–33); haemophilic arthropathy</td>
<td>x</td>
<td>Ilizarov; 2–3 months; 3 (2–4) years</td>
<td>++</td>
<td>++</td>
<td>JSW ++</td>
<td>BD ++</td>
</tr>
</tbody>
</table>

The Ilizarov apparatus is a thin wire circular frame fixed or with a hinge. MRI = magnetic resonance imaging. CT = computed tomography. JSW = joint space width. BD = bone density. BC = bone cysts.

Table 2C  Clinical studies, knee

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Patient characteristics (number, age (years), disease)</th>
<th>Case report</th>
<th>Retrospective</th>
<th>Prospective</th>
<th>Random control</th>
<th>Treatment; duration (months); follow-up (years)</th>
<th>Clinical and structural outcomes</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deie et al. (2007, 2010)\textsuperscript{a}\textsuperscript{b}\textsuperscript{e}</td>
<td>n = 6; 49 (42–63); generalized OA</td>
<td>×</td>
<td>Hinged custom device with bone marrow stimulation; 2–3; 2.6 (1.2–4.3)/3 (2–4.5)</td>
<td>++</td>
<td>++</td>
<td>JSW ++</td>
<td>Cartilage +</td>
<td>Pin-tract infection 2/6</td>
</tr>
<tr>
<td>Abouheif et al. (2010)\textsuperscript{f}</td>
<td>n = 1; 18; large osteochondral defect</td>
<td>×</td>
<td>Hinged custom device with bone graft; 3; 4.5</td>
<td>++</td>
<td>++</td>
<td>JSW ++</td>
<td>Cartilage resurfacing</td>
<td>JSW ++</td>
</tr>
<tr>
<td>Intema et al. (2011)\textsuperscript{g}</td>
<td>n = 20; 48 ± 7; OA</td>
<td>×</td>
<td>Stryker® external fixation tubes; 2; 1</td>
<td>++</td>
<td>++</td>
<td>JSW ++</td>
<td>Cartilage ++</td>
<td>Coll-type II ++</td>
</tr>
<tr>
<td>Aly et al. (2011)\textsuperscript{h}</td>
<td>n = 19 vs. n = 42; (39–65) vs. (41–68); primary OA</td>
<td>×</td>
<td>Stiff Ilizarov with debridement vs. debridement alone; 1; 5.5 (4.8–6.8) vs. 4.3 (3.6–6)</td>
<td>++ vs. +/−</td>
<td>++ vs. +</td>
<td>JSW ++</td>
<td>JSW −</td>
<td>Pin-tract infection; deep-vein thrombosis 1/61; lung embolism 1/61</td>
</tr>
</tbody>
</table>

The Ilizarov apparatus is a thin wire circular frame fixed or with a hinge. MRI = magnetic resonance imaging. CT = computed tomography. JSW = joint space width. BD = bone density. BC = bone cysts.
Table 2D Clinical studies in other joints

<table>
<thead>
<tr>
<th>Joint author, year</th>
<th>Joint characteristics (number, age (years); disease)</th>
<th>Case report</th>
<th>Retrospective</th>
<th>Prospective</th>
<th>Random contr.</th>
<th>Treatment; duration (months); follow-up (years)</th>
<th>Clinical and structural outcomes</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interphalangus-1 van Roermund et al. (1998)35</td>
<td>N = 1; 42; dislocation/fracture</td>
<td>x</td>
<td>Hinged ilizarov; 3.7; 2</td>
<td>+ + + +</td>
<td>Pain</td>
<td>Mobility function</td>
<td>X-ray</td>
<td>MRI</td>
</tr>
<tr>
<td>Proximal interphalangus Bain et al. (1998)36</td>
<td>N = 20; 26 (13–55); Dislocation/fracture</td>
<td>x</td>
<td>Hinged Smith &amp; Nephew Compass*, 1.5 (0.5–2); 0.75</td>
<td>+</td>
<td>Mobility function</td>
<td>X-ray</td>
<td>MRI</td>
<td></td>
</tr>
<tr>
<td>Metatarsal phalanges DeVries et al. (2008)37</td>
<td>N = 1; 15; osteochondrosis</td>
<td>x</td>
<td>OATS with distraction custom device; 1.5; 1.5</td>
<td>+ +</td>
<td>JSW</td>
<td>BD</td>
<td>++</td>
<td>JSW</td>
</tr>
</tbody>
</table>

The Ilizarov apparatus is a thin wire circular frame fixed or with a hinge. OATS = osteoarticular transfer system. MRI = magnetic resonance imaging. JSW = joint space width. BD = bone density.

Discussion

The authors have referenced some of their own studies in this review. These referenced studies have been conducted in accordance with the Declaration of Helsinki (1964), and the protocols of these studies have been approved by the relevant ethics committees related to the institution in which they were performed. All human subjects, in these referenced studies, gave informed consent to participate in these studies.

Joint distraction in treatment of degenerative joint disorders has been applied for almost 20 years now, with mostly positive results demonstrating actual structural tissue repair; pain decrease and improvement of function remaining in the follow-up period (ranging from 0.75 till 10 years). However, only one study could demonstrate a correlation between structural tissue repair and clinical improvement24. The limited number of patients included per study can explain lack of such a relation. Due to the different study designs, a meta-analysis of all patients is not feasible.

Although the presented studies were well documented, they are still of limited quality as only three randomized controlled trials are described. These studies, two on ankle joint distraction and one on knee joint distraction, have a limited number of patients included. Furthermore, these studies have modest follow-up periods of 1, 2 and 5 years. The longest follow-up described until now is 10 years after ankle distraction in severe ankle OA patients35. That study was performed retrospectively and included only 22 patients.

The randomized controlled trial by Saltzman et al.25 showed that a hinged ankle distraction frame is clinically more effective and has better structural results in addition to a higher patient convenience compared with a stiff frame. Structural tissue repair was demonstrated in favour of joint distraction treatment in combination with arthroscopic debridement compared with arthroscopic debridement alone, for both ankle and knee30,32. In all trials, heterogeneity of patients was present, and most patients had several surgical interventions before. Patients often had no other option, in regular care, than arthrodesis or joint replacement.

Some concerns persist on possible latent bone infection due to pin-track infection during joint distraction, increasing the risk of infection after prosthesis surgery. To date, however, no data are available, whereas in some studies uncomplicated prosthesis placement was reported after joint distraction treatment in case of function loss.

Joint distraction induces joint tissue repair and cartilage growth in...
areas of denuded bone, suggesting that joint distraction might also be beneficial for treatment of local cartilage defects as seen in the preclinical models. This hypothetically enlarges the indication of joint distraction in case of cartilage damage. Besides the application as a treatment, joint distraction now provides for the first time the opportunity to study the process of intrinsic cartilage repair. Apparently joint distraction results in a biochemical and biomechanical environment that facilitates (and might even be a prerequisite for) cartilage repair.

Results of future studies should position joint distraction also alongside more common joint-preserving treatments such as microfracture and high tibial ostectomy in a randomized controlled design. Additionally, results should be recorded for longer follow-up periods to investigate the endurance of clinical improvement and structural tissue repair. Furthermore, patient characteristics should be accurately surveyed to determine for which type of OA patient joint distraction is the most optimal treatment.

Conclusion

Joint distraction is a promising joint-preserving treatment of degenerative disorders, resulting in clinical improvement and actual structural joint tissue repair. No other treatment so far enabled such clear intrinsic joint tissue changes. However, it is important that future studies focus on selection of patients, considering phenotypes of onset and stage of the degeneration process to optimize treatment results and provide a most optimal cost-effective treatment. Furthermore, effort is needed in biochemical and imaging markers to demonstrate more subtle changes in tissue repair, preventing the need for biopsies. It would be interesting to see how this approach can work synergistic in combination with other promising cartilage repair therapies, like autologous chondrocyte implantation or disease-modifying osteoarthritic drug treatment. Only with the addition of such sensible and united evaluation of outcomes, joint distraction might be implemented in daily clinical orthopaedic practice.

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Abbreviations list

CT, computed tomography; JSW, joint space width; MRI, magnetic resonance imaging; OA, osteoarthritis; OARSI, OsteoArthritis Research Society International; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index

References


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