

# Conservative treatment of chronic Achilles tendinopathy

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**A**chilles tendinopathy is a common condition, particularly in those who run. It is a chronic, activity-limiting syndrome, defined by the presence of pain and thickening in the Achilles tendon (Figure 1<sup>1</sup>). The lifetime prevalence of Achilles tendinopathy is 52% in former runners, and the annual incidence is 7%–9% in current runners.<sup>2</sup> This syndrome encompasses several overlapping pathologies and is clinically distinct from rupture or partial rupture. Onset is typically insidious and chronic in nature, although occasionally a patient may present with acute tendinopathy.

A classification system for disorders of the Achilles tendon is presented in Table 1,<sup>3,4</sup> based on physical examination, imaging and histopathology. However, there is no widely accepted schema. There has been a largely successful movement to abandon use of the term “tendinitis” for patients with symptoms that last longer than three months, in recognition of the need to address degenerative structural changes within the tendon (i.e., tendinosis) rather than inflammation, which is rarely or only minimally present in most instances.<sup>5</sup> It is often not possible to distinguish tendinosis from paratendonitis (i.e., inflammation around the tendon) and these frequently coexist, which is another argument in favour of the more general term, “tendinopathy.” Nonetheless, an attempt to diagnose the source of pain (tendon v. paratendon) should be made.

The high prevalence among runners points to mechanical loading as an important etiologic factor.<sup>2</sup> In vitro and in vivo research suggests that periods of mechanical overuse result in subclinical evidence of inflammatory or pseudoinflammatory change.<sup>6</sup> The term “pseudo” is used to recognize that full-blown cellular inflammation may not be present in an overloaded tendon; however, tenocytes themselves can produce certain inflammatory mediators in response to increased loading, such as substance P and prostaglandin E2. Over time, these episodes may lead to cumulative changes in the tendon, eventually resulting in the development of tendinosis, paratendonitis or both.<sup>7,8</sup>

There is no universally accepted model of the development of injury from overuse of a tendon.<sup>9</sup> A minority of patients with Achilles tendinopathy

have sedentary lifestyles and no identifiable history of mechanical overload, which suggests that mechanical loading is not the only risk factor.<sup>2</sup> Indeed, multiple risk factors have been identified in small associational studies, including advancing age, male sex, high body mass index, hypercholesterolemia and the presence of genetic variants of genes related to collagen metabolism.<sup>10,11</sup>

The diagnosis can be made on the basis of history and physical examination (Appendix 1, available at [www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.101680/-/DC1](http://www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.101680/-/DC1)). Colour Doppler ultrasonography or magnetic resonance imaging can be helpful in identifying the type of Achilles tendinopathy.

In this review, we discuss the evidence base for conservative management of chronic midportion Achilles tendinopathy. For a discussion of surgical techniques, please see other recent reviews (e.g., Maffulli and coauthors<sup>12</sup>). A plethora of conservative treatments have been suggested to provide relief from, or cures for, Achilles tendinopathy, including nonsteroidal anti-inflammatory drugs (NSAIDs), ultrasound and laser therapy, nutritional supplements, friction massage and dry needling. However, most are not supported by randomized controlled trials. Our objective was to review the evidence found in randomized controlled trials for conservative treatment of chronic (i.e., greater than three months' duration) midportion Achilles tendinopathy (Box 1<sup>13–23</sup>).

## Is exercise an effective treatment?

The only intervention with strong evidence of a treatment effect in randomized controlled trials was heavy-load exercise. This form of exercise

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### KEY POINTS

- Heavy-load (eccentric) exercise is currently the cornerstone of management of chronic Achilles tendinopathy, but it may take up to 12 weeks or longer of daily supervised exercise to see substantial improvements.
- Nonsteroidal anti-inflammatory drugs have little long-term benefit and there is insufficient evidence to support use of shock wave therapy.
- Corticosteroid injections should be avoided and other injection therapies are still in the experimental stage.
- Orthotics may be helpful in patients with an identifiable biomechanical abnormality, but braces and splints have no proven benefit.

varies slightly from trial to trial, but the principal goal is to provide a strong, controlled, mechanical force to the Achilles tendon. This is usually achieved through eccentric (lengthening) muscle activity; for instance, a heel drop over a step. (In contrast, concentric exercise would involve a toe raise that would contract the calf muscles.) As the patient's tolerance of the exercise improves, the load is progressively increased (e.g., by progressing from bilateral to unilateral heel drops, by adding weights in a backpack or through use of gym equipment). Rompe and colleagues found this type of progressive heavy-load exercise to be superior to a wait-and-see strategy, with a 60% success rate in the exercise group (95% confidence interval [CI] 41%–79%) compared with 24% in controls who did not receive treatment (95% CI 7%–41%).<sup>14</sup>

Eccentric exercise was found to be superior to a standard exercise program in a multicentre randomized trial by Mafi and colleagues; 82% of the patients who trained with eccentric exercise were satisfied and had returned to their previous activity level after 12 weeks (95% CI 66%–98%), compared with 36% of patients who trained with standard (concentric) exercise (95% CI 16%–56%).<sup>15</sup> Thus, eccentric exercise induces clinically mean-

ingful effects but may take several weeks or months before a benefit is felt, and not every patient is guaranteed to respond. The exercise should be taught and monitored by a health professional, such as a physiotherapist or sports medicine physician, capable of ensuring correct biomechanics (e.g., avoiding pronation) and of supervising the gradual increase of tendon loading.

The potential harms of eccentric exercise include delayed-onset muscle soreness or exacerbation of the tendinopathy (e.g., pain, soreness or swelling). These typically occur when the exercises are performed too quickly, with incorrect biomechanics or with an increase in load that is too abrupt. There are no published reports of tendon rupture in response to eccentric loading.

### Do orthotics, braces or splints have a positive effect?

Orthotics may be helpful in conjunction with other modalities of treatment if there is an identifiable malalignment, whereas braces or splints do not appear to improve outcomes in Achilles tendinopathy. One randomized controlled trial of male runners found a significant improvement in pain in patients wearing custom-made orthotics.<sup>17</sup> Of the patients, 89% described a reduction in pain scores of greater than 50% after four weeks of wearing custom insoles (95% CI 69%–100%), compared with 0% in control patients who did not receive treatment ( $p < 0.05$ ). This trial may have had improper blinding, because sham insoles were not provided to the control group. Referral to a qualified orthotist should be considered if the biomechanical examination identifies a potentially correctable malalignment. However, there is little evidence to suggest that orthotics alone will be effective.

An inflatable brace was examined in two separate studies. The brace is commercially available (AirHeel [Aircast]) and designed to be worn during activity. An earlier study by Petersen and coworkers could not detect differences between groups and recommended further study.<sup>20</sup> In a subsequent larger study, Knobloch and colleagues randomly assigned 116 patients to undergo treatment consisting of eccentric training or eccentric training plus prescription of an AirHeel brace. Both groups achieved similar improvements in pain after 12 weeks, which showed that the addition of the AirHeel brace did not improve the success of rehabilitation.<sup>19</sup>

Other authors have advocated use of a night splint, as commonly prescribed for patients with plantar fasciitis. de Vos and colleagues randomly assigned patients to complete a heavy-load



**Figure 1:** Schematic view of the Achilles tendon. Left: Normal tendon showing a white glistening appearance, with tightly bundled type I collagen fibres, sparse cellularity and minimal vascularity. Right: Tendinopathic tendon showing a yellowish or greyish appearance, with underlying findings of tendinosis, which may include smaller and more disorganized fibrils, increased cellularity and vascularity, and increased proteoglycan (blue) and lipid (yellow) accumulation. Reproduced with permission from Brukner and Khan.<sup>1</sup>

eccentric training program with or without use of a night splint. After 12 weeks, 63% of patients in the group that received only exercise were satisfied (95% CI 47%–79%), compared with 48% in the night splint group (95% CI 32%–64%), and there were no significant differences in pain or other outcome measures.<sup>21</sup>

## What is the role of physiotherapy?

Many clinicians recognize that an individualized physiotherapy program that addresses the patient's specific presentation, loading history and biomechanics leads to the most effective outcomes when combined with exercise. However, published evidence for these complex interventions is still lacking, particularly for longer-term outcomes.

One trial examined the short-term effect of physiotherapy, including ice, transverse friction massage, therapeutic ultrasound and exercise (i.e., concentric, eccentric, balance and proprio-

ceptive drills), compared with control (no treatment).<sup>17</sup> The physiotherapy group ( $n = 11$ ) experienced significant improvements in activity-related pain compared with controls ( $n = 8$ ) ( $p < 0.05$ ). Effect size could not be calculated, which made a comparison with other trials that used exercise alone impossible. The trial included only men and used a multimodal intervention that closely approximates interventions currently provided by many sports medicine physiotherapy clinics, rather than exercise alone.

## Which other modalities may be helpful?

Many modalities have been used in the treatment of chronic Achilles tendinopathy. Some that are used frequently, such as NSAIDs, have little long-term benefit, whereas current evidence for less commonly used options, such as extracorporeal shock wave therapy and glyceryl

**Table 1:** Classification of disorders of the Achilles tendon, with typical findings<sup>3,4</sup>

Pathologic diagnosis	Concept (macroscopic pathology)	Physical examination	Imaging	Histopathology
Tendinosis*	Intratendinous degeneration	Tendon thickening and tenderness on palpation of the midportion	Hypochoic areas on grey-scale ultrasonography; increased tendon thickness; increased colour Doppler signal, usually originating from deep surface	Collagen disorientation, disorganization and fibre separation; hypervascularity; variable tenocyte density (usually increased fibroblastic and myofibroblastic cellularity); evidence of microtears (fibrin, hemosiderin)
Paratendonitis*	Inflammation of the outer layer of the tendon (paratendon)	Crepitus	Paratendinous edema	Mucoid degeneration and scattered inflammatory cells in the paratendon
Paratendonitis with tendinosis*	Paratendonitis associated with intratendinous degeneration	Combinations of the above	Combinations of the above	Degenerative changes as noted in tendinosis, with mucoid degeneration, with or without fibrosis, and scattered inflammatory cells in the paratendon
Partial rupture	Macroscopic defect of collagen fascicles	Tendon thickening; pain on stretch; marked weakness	Collagen defect on grey-scale ultrasonography; increased colour Doppler signal, usually on superficial surface	Evidence of tearing, inflammation and granulation tissue; adjacent areas often show tendinosis
Complete rupture	Complete loss of continuity of tendon fibres	Lack of strength on plantar flexion; Homan sign	Obvious defect on ultrasonography	Evidence of tearing, inflammation and granulation tissue; adjacent areas often show tendinosis
Insertional disorders	Injury, inflammation or degeneration of the osteotendinous junction, bursae or both	Tendon thickening and tenderness on palpation of the insertional area	Hypochoic areas or defects adjacent to the calcaneus; bursitis; defects of the calcaneus	Not available

\*As a group, these diagnoses are referred to as Achilles tendinopathy.

dinitrate, is inconclusive. Corticosteroid injections should be avoided, and other injection therapies require more research before they can be recommended.

### Nonsteroidal anti-inflammatory drugs

This review did not identify a randomized controlled trial of NSAIDs that met the inclusion criteria of symptoms lasting longer than three months. One trial of NSAIDs included some patients with chronic Achilles tendinopathy of less than six months' duration; that trial was rejected for inclusion during the initial literature search (Appendix 1, available at [www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.101680/-/DC1](http://www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.101680/-/DC1)) because it also included patients with acute Achilles tendinopathy.<sup>24</sup> This trial found identical treatment outcomes in 70 patients randomly assigned to receive piroxicam or placebo tablets. The study is consistent with the clinical experience of one of us (K.K.) and with a lack of effect of NSAIDs in other types of tendinopathy.<sup>25</sup>

### Injection therapies

A variety of injection therapies for the treatment of chronic Achilles tendinopathy has been examined in small clinical studies. These treatments include corticosteroids, sclerosing therapy, aprotinin, polidocanol, glycosaminoglycan polysulfate and platelet-rich plasma.<sup>26-32</sup> Several studies

have reported trends that are consistent with a clinically significant improvement, but are hampered by the small number of patients studied.

Fredberg and colleagues randomly assigned 24 patients with midportion Achilles tendinopathy to receive ultrasonography-guided corticosteroid (20 mg triamcinolone) or placebo injections.<sup>29</sup> The authors commented that a significant number of patients treated with corticosteroid injection experienced initial improvements followed by a relapse of symptoms, but it is difficult to extract this information from the trial. An older study that included instances of both acute and chronic Achilles tendinopathy was not included in the current review, but we note here, in the absence of other available evidence, that these authors reported a lack of success with corticosteroid injection for the subset of patients with chronic Achilles tendinopathy.<sup>28</sup>

One randomized controlled trial examined the effect of injection of platelet-rich plasma on patients with Achilles tendinopathy; however, the study included patients with relatively acute conditions (two months' duration of symptoms) and thus did not meet our a priori inclusion criteria.<sup>33</sup> Platelet-rich plasma is sometimes considered for instances of chronic, refractory tendinopathy, but there is as yet no evidence from randomized controlled trials to support or refute its use for chronic midportion Achilles tendinopathy.<sup>32</sup>

### Extracorporeal shock wave therapy

The current evidence for shock wave therapy as a treatment for Achilles tendinopathy is inconclusive. Shock wave therapy involves the application of acoustic waves that vary in nature according to the type of device used and the amount of energy and energy flux delivered to the tissue. Because of the pain associated with active shock wave treatment, none of the available trials are adequately placebo-controlled. The evidence that met our criteria rests on two trials.<sup>14,18</sup>

One trial examined the effect of adding low-energy (0.1 mJ/mm<sup>2</sup>) extracorporeal shock wave to a heavy-load eccentric exercise program. Patients who were randomly assigned to receive active shock waves plus exercise fared slightly better in terms of pain (1.5/10 improvement on a visual analogue scale;  $p = 0.0045$ ), activity level (13.5/100 improvement on the Victorian Institute of Sports Assessment–Achilles [VISA-A] score;  $p = 0.016$ ) and satisfaction with treatment at four months.<sup>18</sup> Although statistically significant, these values may be clinically insignificant.

### Glyceryl trinitrate

Two randomized controlled trials examined the effect of placing patches of glyceryl trinitrate

#### Box 1: Summary of the literature review

We performed an English-language literature review of randomized controlled trials of treatment for chronic Achilles tendinopathy. Appendix 2 (available at [www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.101680/-/DC1](http://www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.101680/-/DC1)) includes a complete description of our literature review. To be included, a study had to be a single- or double-blind randomized controlled trial of patients with chronic midportion Achilles tendinopathy. We included exercise trials that were single- as opposed to double-blind in design because exercise is a key component of management for chronic Achilles tendinopathy.

We searched Ovid MEDLINE (1950–August 2010) using a strategy combining terms related to Achilles tendinopathy with a search string for randomized controlled trials. In addition, we searched The Cochrane Library for systematic reviews of agents used for treating Achilles tendinopathy. The abstracts of identified studies were screened for relevance, relevant papers were reviewed independently by A.S. and E.H. and reference lists were further hand searched.

The methodologic quality of included studies was assessed independently by A.S. and E.H. using the Oxford scale, also known as the Jadad scale.<sup>19</sup> We extracted data from the studies, calculated the Cohen's effect sizes ( $d$ ) and tabulated the results.

Our search strategy identified 72 randomized trials of which 11 met the above inclusion criteria (Appendix 2). Included papers and their results are listed in Table 2.<sup>13-23</sup>

In the reviewed studies, a total of 777 patients were enrolled. The average age of the patients was 45.6 years, ranging from 18 to late 70s. The ratio of male to female patients was not reported for all trials; the ratio in reported trials was 0.51 male to female. The duration of symptoms ranged from three months to several years. The most common outcome measures were pain at rest or with activity.

directly over the painful Achilles midportion. Nitric oxide is essential to achieve normal healing of the tendon after acute injury; therefore, it may also be helpful in promoting repair of chronic injuries.<sup>34</sup>

Paoloni and colleagues randomly assigned 65 patients to receive rehabilitation (focusing on active tendon-loading exercises) plus glyceryl trinitrate for six months, or identical rehabilitation with placebo patches.<sup>23</sup> The primary outcome measure was patient-rated tendon pain with activity. Four patients did not conclude the trial because of the development of headaches or skin rashes. In those who remained in the

trial, there was a statistically and clinically significant decrease in pain with activity ( $p = 0.03$ ). A second study by Kane and coauthors examined the effects of patches of glyceryl trinitrate and eccentric exercise versus placebo patches and eccentric exercise in 40 patients (20 per group). The main outcome measures were the Ankle Osteoarthritis Scale pain and disability scores. The scores of both groups were significantly decreased at six months, but the average scores were identical in the two groups.<sup>22</sup> Thus, the initial promising results from Paoloni and colleagues' trial have not been supported by similar studies in other centres.

**Table 2:** Results of randomized controlled trials of treatment for chronic Achilles tendinopathy included in the review

Intervention	Impression of efficacy	Study	Oxford score <sup>13</sup>	Study participants (study details)	Outcome measures	Cohen's effect size
Exercise	Effective	Mafi et al. <sup>15</sup>	3	F = 20, M = 24	Visual analogue scale	Could not be calculated
		Silbernagel et al. <sup>16</sup>	1	F = 13, M = 36	Pain on palpation	Could not be calculated
					Pain during activity	Could not be calculated
		Mayer et al. <sup>17</sup>	2	F = 0, M = 20	Pain Disability Index	Could not be calculated
		Rompe et al. <sup>18</sup>	3	<i>n</i> = 50 total (eccentric exercise v. wait and see)	Pain Experience Scale	Could not be calculated
					VISA-A questionnaire	Large ( $d = 1.28$ )
					Likert scale	Large ( $d = -1.03$ )
Orthotics	Insufficient evidence	Mayer et al. <sup>17</sup>	2	F = 0, M = 21	Pain	Large ( $d = -1.11$ )
					Pain Disability Index	Could not be calculated
AirHeel brace (Aircast)	Not effective	Knobloch et al. <sup>19</sup>	3	F = 34, M = 63	Pain Experience Scale	Could not be calculated
		Petersen et al. <sup>20</sup>	3	F = 40, M = 60	Visual analogue scale	Mild ( $d = -0.29$ )
					Foot and Ankle Outcome Score	
					Symptoms	No effect ( $d = 0$ )
					Pain	No effect ( $d = -0.10$ )
Sports	No effect ( $d = 0.04$ )					
Night splint	Not effective	de Vos et al. <sup>21</sup>	3	F = 26, M = 37	Quality of life	No effect ( $d = 0.12$ )
					VISA-A	Could not be calculated
Shock wave therapy	Insufficient evidence	Rompe et al. <sup>18</sup>	3	F = 38, M = 30 (group 1: eccentric training; group 2: eccentric training and shock wave therapy)	VISA-A	Large ( $d = -0.77$ )
					Likert scale	Moderate ( $d = 0.54$ )
					Pain	Large ( $d = 0.71$ )
		Rompe et al. <sup>14</sup>	3	F = 46, M = 29 (group 1: eccentric training; group 2: shock wave therapy; group 3: wait and see)	VISA-A	Group 1 v. 2, small ( $d = 0.30$ )
						Group 1 v. 3, large ( $d = 1.28$ )
					Likert scale	Group 2 v. 3, large ( $d = 1.05$ )
						Group 1 v. 2, no effect ( $d = -0.13$ )
						Group 1 v. 3, large ( $d = -1.03$ )
					Pain	Group 2 v. 3, large ( $d = -0.90$ )
						Group 1 v. 2, no effect ( $d = -0.18$ )
Glyceryl trinitrate	Insufficient evidence	Kane et al. <sup>22</sup>	4	<i>n</i> = 40	Group 1 v. 3, large ( $d = -1.11$ )	
		Paoloni et al. <sup>23</sup>	4	<i>n</i> = 65	Group 2 v. 3, large ( $d = -0.95$ )	
				Pain	Could not be calculated	
				Pain with activity	Large ( $d = -3.50$ )	

Note: F = female, M = male, VISA-A = Victorian Institute of Sports Assessment–Achilles.

## What is the prognosis?

Although tendinopathy may seem like relatively benign soft tissue pathology, recovery often follows a prolonged time course, even with ideal treatment. In one retrospective case series, 29% of patients who presented with symptoms of less than six months' duration were eventually referred for surgery. However, this series was published more than 10 years ago and may not reflect current successes with comprehensive rehabilitation.<sup>19</sup> Because traditional surgical management has only a 50% rate of success, it is essential to ensure that the best conservative management has been offered before consideration of surgery.<sup>20</sup>

The recalcitrant nature of chronic Achilles tendinopathy was documented by Rompe and colleagues, who noted that there was a slow but gradual improvement in the average load-induced pain score from 7.9/10 to 5.9/10 over the course of four months in patients not receiving treatment. After this period, only 24% of

these patients reported themselves as much improved or cured.<sup>14</sup>

In the long term, the prognosis of chronic Achilles tendinopathy is more favourable. At eight-year follow-up in one study of 83 patients, 80% of patients were back to full physical activities, whereas 20% reported that their physical activity was still impaired as a result of the Achilles tendinopathy. All patients could walk normally and had equal plantar flexion strength bilaterally, and 94% of patients could run normally.<sup>19</sup>

Box 2<sup>3,15,16,18,23,35,36</sup> provides an example of the management of chronic Achilles tendinopathy, using the results of our literature review.

## Gaps in knowledge

As summarized in Table 2, the evidence base for treatments other than exercise remains tenuous. Additionally, we do not know how different patient populations may respond to exercise. Clearly, young patients with active lifestyles may expect a better response to exercise than older patients with sedentary lifestyles, but response may be highly individualized. There is no magic formula for exercise prescription, and better data on prognostic factors would greatly assist clinicians in fine tuning their practice and advance our knowledge base.

Can exercise be used to prevent Achilles tendinopathy? Tendon does have an ability, like muscle or bone, to adapt to increased functional demand; however, this may not necessarily translate into an ability to prevent injuries.<sup>37</sup> Will some of the pilot studies of ultrasonography-guided injection treatments be born out in larger randomized controlled trials? These are some of the many gaps in knowledge that we hope will be addressed in the coming years.

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### Box 2: Applying the results of this review in clinical practice (fictional case)

The role of the primary care physician is to establish the history and diagnosis, provide education on the chronic nature of the condition and the importance of rehabilitation, provide a referral to physiotherapy and monitor progress through rehabilitation (e.g., 6 or 8 weeks' follow-up).

A healthy 40-year-old woman presents with a four-month history of gradual onset of pain along her Achilles tendon, which has forced her to give up recreational running (her preferred form of exercise). She is 168 cm tall and usually runs 7–10 km per day, five days per week. There is no history of trauma or an obvious episode of strain or sprain. The pain is variable but is present throughout the day and also at night. It becomes severe with any attempt to start running again. Initially, the pain seemed to improve with ibuprofen, but now this gives no substantial benefit. There is no history of inflammatory disorder, diabetes or familial hypercholesterolemia. Physical examination shows a painful thickening in the midportion of the Achilles tendon, which triggers a sharp, localized pain when palpated. Radiography is normal. Ultrasonography shows thickening of the Achilles tendon with hypochoic areas. What is the preferred treatment?

This patient requires education about the chronic, noninflammatory nature of the condition<sup>3</sup> and the crucial role she will have to play in making rehabilitation successful. She would benefit from a biomechanical assessment and a closely supervised exercise program with a graduated return to activity, both of which can be conducted by an appropriately experienced physical therapist.<sup>15,16</sup>

The use of a diary and the self-administered Victorian Institute of Sports Assessment–Achilles (VISA-A) scale<sup>36</sup> may be useful in helping patients keep track of their exercise and their level of pain or function.<sup>16</sup> The clinician could prescribe a glyceryl trinitrate patch<sup>23</sup> or a course of low-energy shock wave therapy in combination with exercise if there is no improvement after 4–8 weeks,<sup>18</sup> but these treatment options should be suggested with the caveat that the evidence for their efficacy is inconclusive. Exercise should be continued while these adjuvant therapies are trialed. If the condition remains unresponsive to treatment and the patient has substantial pain after six months, then further imaging and a surgical referral could be considered, preferably for a minimally invasive procedure.<sup>35</sup>

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