

Comparative Effect of Calisthenic and Proprioceptive Exercises on Pain, Proprioception, Balance and Function in Chronic Osteoarthritis of Knee

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Abstract

Aim: the present study was intended to study the effect of calisthenic exercises and to compare effectiveness of calisthenics and proprioception exercises as an adjunct to conventional treatment in subjects with chronic Osteoarthritis knee. **Method:** It was randomized clinical trial. 43 participants diagnosed with chronic osteoarthritis knee were randomly allocated into two group's viz. Calisthenic exercise group and Proprioception exercise group. The outcome measures were pain, proprioception deficit, balance and functional disability. **Result:** Both intervention groups showed significant improvement when pre and post values were analyzed for all the outcome parameters ($p < 0.05$). But, inter group comparisons showed Proprioceptive exercise group to be more effective ($p < 0.05$) than Calisthenic exercise group for all outcome parameters except for functional disability scale. **Conclusion:** Light intensity Calisthenic exercises are effective and can be recommended as an adjunct to conventional physiotherapy for the patients with Osteoarthritis knee. However, proprioceptive exercises were superior to calisthenic exercises when prescribed along with conventional physiotherapy.

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Introduction

Osteoarthritis (OA) is the second most common rheumatologic disorder after soft tissue rheumatism. It's the most common rheumatic disease and a leading cause of pain and disability. Osteoarthritis is marked by progressive destruction of articular cartilage and formation of bones at the margins of the joint (Klippel et al. , 1997; Linos et al.,1980; Sokoloff 2016). Anepidemiology study conducted to determine region-specific prevalence of knee osteoarthritis and risk factor profiles in India, found overall prevalence of knee OA was found to be 28.7% (Chandra et al., 2016). In India, the rheumatologic disorder affects 10 -20% of the population across different ages. As put forth by the American College of Rheumatology the criteria for osteoarthritis includes age of 50 years and above, regular experience of knee pain, crepitus on motion coupled with either osteophytes findings on the radiograph or combination of morning stiffness lasting for 30 minutes or less.(Bhan 2002; American College of Rheumatology 2012). As the disease progresses the

functional activities in weight bearing positions like standing, kneeling, squatting, stair climbing, walking and stooping become more difficult and painful. Studies done so far have seen the prevalence of pain, proprioceptive deficit and quality of life affection as the dynamic and the static stability is disturbed in knee joint due to disturbances produced between the agonist and the antagonist that leads to the etiopathogenesis of knee pain. Thus, selection of outcome measures need to be inclusive of multiple factors so as to address and assess the above mentioned impairments. (O'Brien 2009). The severity of Knee OA can be graded radiologically by Lawrence – Kellegren classification. A study was done to investigate agreement between radiographic OA using Lawrence – Kellegren classification and the clinical and self-reported diagnoses of OA knee which concluded that there was modest agreement between the radiographic, clinical and self-report methods of diagnosis of knee OA. (Parsons et al., 2001). Physical therapy management of OA knee is directed towards reducing joint pain and stiffness, maintaining and improving joint mobility, reducing physical disability and handicap, improving health-related quality of life, limiting the progression of joint damage. There are many emerging evidences showing that light to moderate intensity physical activities play a preventive and restorative role in the health and functional capacity caused by osteoarthritis. (American geriatric society 2001). Studies have been established regarding beneficial effects of exercise in patients with mild to moderate OA of the knee. Therapeutic exercises which are generally prescribed include stretching, static and dynamic strengthening, aerobic and proprioceptive exercises. (Kisner 2007). The studies have reported the exercise to be effective in reducing pain and improving physical function. The role of proprioceptive exercises has been extensively researched and has shown to be an effective therapeutic measure in the treatment of OA knee. These exercises have shown to cause dynamic stabilization by synergistic and synchronous working of muscle groups. (Esser et al., 2011; Diracoglu 2005). Hence, proprioceptive exercises are being prescribed on routine basis to all the patients with OA knee. Calisthenic exercises of low intensity have recently been suggested by few clinicians to the OA knee patients. Calisthenic exercises comprise of several short muscle contractions intended to increase the body flexibility and strength using one's own body weight. These exercises are rhythmical movement exercises that increase the strength and flexibility (National Institute of Aging Press 1996). Routinely, calisthenic exercises have been prescribed as part of warm up before aerobic exercises are performed. However, it is not been studied through scientific based research that prove its effectiveness in subjects with OA knee. Though there are many studies that justify the significance of proprioceptive exercises to be beneficial in the management of OA knee, there are limited studies done to support the efficacy of Calisthenic exercises in OA knee. Hence, the present study had two objectives. The first objective was to find the effect of light intensity calisthenics in the treatment of chronic OA knees as an addition to conventional physiotherapy. The second objective of the study was to compare the effectiveness of proprioceptive versus calisthenic exercises along with conventional physiotherapy in subjects with OA knee and to determine whether a difference of treatment efficacy exists among the two exercise modes.

Materials and Methods

This study was a single blinded (assessor blinded) randomized clinical trial with a sample of convenience. Ethical clearance for the study was obtained by the Institutional Ethical Review Committee following which the study participants were screened for inclusion and exclusion criteria. All participants gave written informed consent prior to commencement of the study. Participants' rights were protected throughout the trial. This study was conducted in the Physiotherapy department of Tertiary care center of Belagavi city, India.

Consecutive presentations of people with a referral for OA treatment to the Physiotherapy Department were screened. Participants who were clinically and radiologically with OA knee were

recruited and further assessed for eligibility for inclusion and exclusion criteria. The inclusion criteria were (1) Subjects with chronic OA (symptoms for more than 3 months) (IngemarP . , 1997) (2) age group between 45 -65years (Ingemar 1997) (3) Grade of 2 or 3 as per Kellegren and Lawrence radiographic classification(Ingemar 1997) (4) Subjects willing to participate and take treatment for 10 sessions. Participants were excluded if they were (1) subjects having any systemic joint pathologies, inflammatory joint disease (e.g. rheumatoid arthritis, gouty arthritis, psoriatic arthritis) (2) subjects who had any neurological deficit (parasthesia, sensory loss, radiculopathy, myelopathy) (3) any mental illness(Dementia, Alzheimer’s, Parkinson disease etc.) that can affect orientation and concentration (4) Subjects on medication like antidepressants, corticosteroid, anti-inflammatory medications (5) Peripheral vascular diseases (5) Any history of surgery related to lower extremity (6) Subjects having metal implants in the lower limb (7) subjects who have undergone physiotherapy treatment for same condition in recent 6 months.

The randomization sequence was created using chit method by a researcher not involved with treatment or outcome measure assessment. The subjects picked up any one chit (labeled group A or B). Following this, they were assigned to Proprioceptive group (PE) or Calisthenic group (CE). A total of 61 patients were referred to physiotherapy for treatment of OA during the study period. The subjects underwent an assessment for eligibility to participate in the study. Out of 61, 43 participants met all the criteria and progressed to participate in the trial (Figure 1).

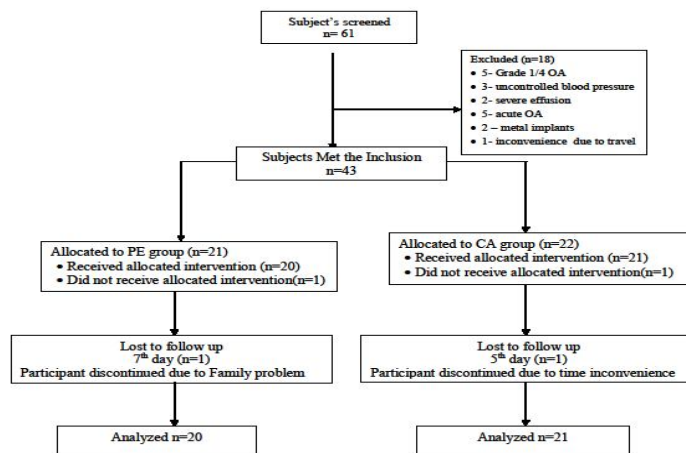


Figure 1. Flow chart depicting the allocation and randomization

The study participants were given brief idea about the nature of the study and intervention. The total intervention lasted for 10days with one session per day. Short wave diathermy (SWD) and supervised isometric exercises were given as a part of the conventional treatment for all the

participants (both groups) the therapy was given for 45min. The Assessor was blinded to the intervention.

Proprioceptive exercises (Srinivas et al . , 2012) (Group A): The participants in this group received proprioceptive exercises+ conventional exercises +SWD. The proprioception exercises given were:(1) One leg balance hold time (3 repetition), (2) Toe walking (30 steps), (3) Heel walking (30 steps), (4) Forward leg swings (15 swings), (5) Side way leg swings(15 swings), (6) One leg heel raise (15 repetitions), (7) One leg squats (10 repetitions).

PROPRIOCEPTIVE EXERCISES



Calisthenic exercises (National Institute of Aging Press. , 1996 ,Sandra and Nielsen 1992) (**Group B**): The participants in this group received calisthenic exercises +conventional exercises +SWD. Low intensity calisthenic exercises were given. Each exercise was performed for 10 minutes with 10 repetitions of each exercise with no rest periods. The exercises given were: (1) Abductor-Adductor leg raise, (2) Alternate toe touch, (3) Knee Bend, (4) Prone leg extension, (5) Lunges (6) Toe Raise/ Calf raise, (7) Leg kicks/lifts, (8) Jack Twists.

CALISTHENIC EXERCISES



CONTD.

Both the treatment groups received continuous mode short wave diathermy in contra planar method using pad electrodes for 20 minutes per day. The conventional exercises integrated in both the groups included: isometric quadriceps, isometric hamstrings, tendo-achilles stretching, hamstrings stretching and vastusmedialis stretching. Each exercise was performed for 10 repetitions.

Baseline demographic data for age, gender, height, weight, side affected, duration of symptoms and the grade of radiograph were collected from all the participants. Initial evaluation of pain intensity was done using Visual Analogue Scale (VAS). The participants were asked to mark a point on a 10cm line where 0 represents no pain and 10 represents unbearable pain following which the severity of his/ her was noted. (Price et al. , 1983).

Proprioception angle for affected knee was measured by digital goniometry; the subjects were made to sit with back support the rotation centre of digital goniometer was placed in lateral aspect of knee joint. They were instructed to obtain the target angle of 45⁰ knee flexion. Then the patient was commanded to close eyes and achieve target angle with 3 repetitions and the deviation of average was taken. Averages of the three measurements were taken on pre and post intervention (Michael 2010; Akseki et al., 2008).

The balance was assessed using functional reach scale a yard stick was mounted on the stand and positioned at subject's acromion process of scapula. The subject was made to stand sideward's next to mounted yardstick without touching it, feet at normal stance and weight equally distributing on both the feet. The shoulder were flexed at 90⁰ and elbow extended with hand fist. Initial measurement was made from the 3rd metacarpal along the yardstick. Then, the subjects were asked to lean forward as far as possible and again measurements were taken (Duncan et al.,1990).The measurements were subtracted from the initial measurement.

Functional disability was measured using Western Ontario Macmaster Osteoarthritis Disability Index (WOMAC) (Woo et al., 2003) the measurement was taken on 1st and 10th day of intervention. A sample size of 40 participants was calculated with minimum of 20 subjects in each group with 80% power and alpha value of 1.96 for detecting a difference between both the treatment groups. The sample size was calculated referring previous articles (Betul et al., 2016; Sung-Bum et al., 2015). Statistical analysis was done using SPSS 16 version. Various statistical measures such as mean, standard deviation and tests of significance were applied. Chi-Square test was applied for age, BMI, sex, side affected and Kellgren Lawrence radiographic classification. The 't' test of significance was applied for within and between group analyses for dependent variables. Probability values less than 0.05 were considered statistically significant.

Results

At the end of 10th day of intervention, 41 participants were evaluated. Twenty of the subjects (mean age \pm SD 52 \pm 6.11years, body-mass index [BMI] 26 \pm 4.95 kg/m²) were in the proprioceptive exercise group and 21 of them (mean age \pm SD 56.60 \pm 5.88 years, BMI 25 \pm 4.00 kg/m²) were in the calisthenic exercise group. In this study the gender ratio of female participants was more than that of male participants. The radiographic evaluation of OA knee stated that maximum number of participants belonged to grade 3 OA (Table 1).

Table 1. Demographic characteristics and baseline values

Demographic Details		Proprioception (n=20)	Calisthenic (n =21)	p value
Age ^a		52.70±6.11	56.60±5.88	0.056
BMI ^b		26.93±4.95	25.74±4.00	0.738
Gender % (n) ^c	Males	40.00 (8)	15 (3)	>0.05
	Females	60.00(12)	85(17)	>0.05
Kellgren Lawrence grading % (n) ^c	Grade2	20 (4)	20 (4)	>0.05
	Grade 3	80 (16)	80 (16)	>0.05
Pain ^a		7.82 ± 1.54	7.82 ± 1.54	0.2977
Proprioception ^a		40.40 ± 4.33	40.40 ± 4.33	0.1297
Balance (FRT) ^a		27.65 ± 3.21	27.65 ± 3.21	0.9475
Functional disability (WOMAC) ^a		45.80 ± 16.12	45.80 ± 16.12	0.4425

a – unpaired t test; b – Mann Whitney U test; c – standard error of mean

In both proprioception and calisthenic groups, the analysis of pre to post intervention comparison resulted in statistically significant reduction in pain scores (PE=7.82 ± 1.54/3.99 ± 1.78) (CA= 7.17 ± 1.97/5.52 ± 1.86) and reduction in knee functional disability scores (PE=45.80 ± 16.12/29.60 ± 15.46) (CA=39.90 ± 14.51/30.55 ± 12.72) [Table 2], improvement in proprioceptive error at 45° of knee flexion (PE=40.40 ± 4.33/43.58 ± 1.22) (CA=38.55 ± 5.78/40.49 ± 4.45) [Table 3], better balance scores (PE=27.65 ± 3.21/32.62 ± 3.64) (CA=27.89 ± 2.06/30.14 ± 1.09) (Table 4).

Table 2. Inter group comparison for Pain and Functional outcomes

Groups	Pain (VAS) scores		Functional (WOMAC) scores		P value
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	
Proprioception Group	7.82 ± 1.54	3.99 ± 1.78	45.80 ± 16.12	29.60 ± 15.46	< 0.001*
Calisthenic Group	7.17 ± 1.97	5.52 ± 1.86	39.90 ± 14.51	30.55 ± 12.72	< 0.001*
p-Value	0.2977	0.014*	0.4425	0.9755	

*p<0.05# paired t test

Table 3. Inter group comparisons for Proprioceptive Angle at 45° knee flexion

Groups	Pre-intervention	Post-intervention	p Value
Proprioception Group	40.40 ± 4.33	43.58 ± 1.22	< 0.001*
Calisthenic Group	38.55 ± 5.78	40.49 ± 4.45	< 0.001*
p-Value	0.1297	< 0.001*	

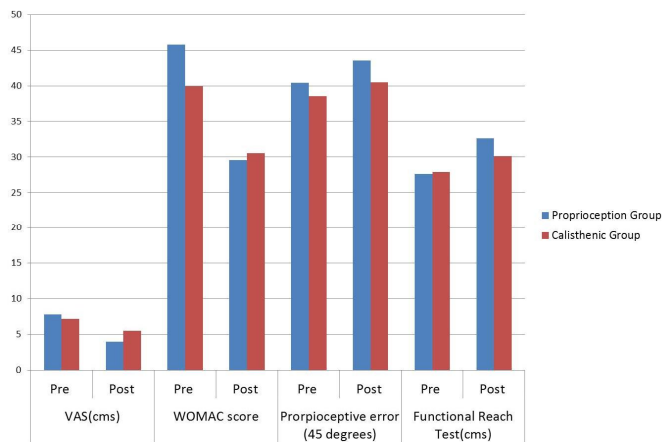
*p<0.05, # paired t test

Table 4. Inter group comparisons for Functional Reach Test

Groups	Pre-intervention	Post-intervention	p Value
Proprioception Group	27.65 ± 3.21	32.62 ± 3.64	< 0.001*
Calisthenic Group	27.89 ± 2.06	30.14 ± 1.09	< 0.001*
p-Value	0.9475	0.004*	

*p<0.05, # paired t test

The inter group comparison demonstrated statistically significant results where proprioceptive group had superior improvement over calisthenic group in all the outcome parameters except for functional disability scores for knee (Figure).



Discussion

The present trial was conducted to evaluate effect of light calisthenics on knee OA and to compare the effect between calisthenic exercises and proprioceptive exercises. It can be inferred from the results that calisthenics exercises are beneficial to treat OA knee patients. Further, the results demonstrated proprioceptive exercises to be better effective than calisthenic exercises for pain, proprioception and balance except for functional disability. Osteoarthritis is a degenerative disease with secondary changes in the bone with the main complaints of the patients often being knee pain. Exercises play a major role in the management of knee osteoarthritis. Many studies established have shown beneficial effects of exercise in patients with mild to moderate knee osteoarthritis. (American geriatric society.,2001 ; Kisner et al., 2002).The growing body of evidences has shown efficiency of exercises on pain and functional disability. According to the Standing Committee for International Clinical Studies including Therapeutic Trial recommendations for knee osteoarthritis management have clearly stated use of exercises that are directed towards increasing the strength of quadriceps and preserving the normal mobility of knee (Srinivas et al., 2012; Zhang et al., 2008; Diracoglu et al., 2005).The present study demonstrated significant improvement with calisthenic exercises for all outcome parameters when it was applied together with conventional physiotherapy treatment calisthenics are routinely used training exercises in rehabilitation and sports as they lead

to improved strength and flexibility reflecting on better performances and lower injury rates (Diego et al., 2015; Ozer et al., 2012). The improvements seen in the present study can be attributed to the fact that calisthenic exercises promote contraction of multiple muscle groups. In the long run, this exercise promotes weight loss by burning fat. This type of exercises also is said to enhance the flexibility (Diego et al., 2015). The positive results of the present study are in accordance to many prior studies conducted. A randomized control trial study was conducted to assess the effect of calisthenic exercises alone with conservative therapy on pain threshold pain, severity and muscle strength on sedentary women with low back and upper extremity pain the authors concluded that calisthenic exercises administered along with conservative treatment increases pain threshold and muscle strength than only conservative treatment (Betul et al., 2016). Another study by Iwamoto et.al (Iwamoto et al., 2009) studied calisthenic exercises along with balance-flexibility-walking exercises for 5 months resulted in significant improvement in flexibility and strength. Yet another study demonstrated higher pain threshold values in patients with fibromyalgia syndrome who received calisthenic training (Baştuğ and Gultekin., 2008). A significant reduction in VAS scores and increase in muscle endurance was shown in a study by Keser et.al where calisthenic exercises were administered in patient population with multiple sclerosis (Keser et al., 2011). Therefore our study also confirms the effectiveness of calisthenics in reducing pain and improving quality of life. Although calisthenic exercises are used in various rehabilitation programs for different patient population, there are no studies done to assess effect of these exercises in OA knee population. In the previous literature, it is recommended that moderate intensity calisthenics exercises have been identified as an alternative strength training exercises due to practicality and value (Ozer et al., 2012; Sekir 2005). The present study included only light intensity of calisthenic exercises since the study population belonged to an older age group who had degenerative joint disease. There is lack of literature support where high intensity of calisthenic exercises have been prescribed or assessed in lower limb degenerative conditions (Betul et al., 2016 ; Ozer et al., 2012). The results also indicate that proprioceptive exercises to be effective in treating patients with OA knee. Literatures suggest that proprioceptive information is an important mediator of timely and appropriate voluntary and involuntary movements. Proprioceptive exercises cause dynamic stabilization by the synergistic and synchronous working of the muscle groups. Exercise regimens containing repetitive movements increase the ability of the person's control over joint movements in all positions. Dynamic stability helps to control abnormal joint translation that occurs during daily movements and may provide increased motor control through a reflex route (Lin et al., 2013). Many previous studies have shown efficacy of proprioceptive exercises on balance, proprioceptive perception, and gait parameters in knee osteoarthritis. (Srinivas et al., 2012). Literature review suggest proprioceptive exercises have better relief of pain and functional disabilities in patients with OA knee (Demirhan et al., 2005). Similar results have been attained in a controlled study done by Sung-Bum Ju et.al where effects of proprioceptive circuit exercise were studied on knee joint pain and muscle function in patients with knee OA the authors concluded proprioceptive exercises to be an effective way to strengthen muscles and reduce pain (Sung-Bum et al., 2015). A systematic review was conducted to study the effectiveness of proprioceptive training for improving motor function. The conclusion suggest that there is converging evidence suggesting proprioceptive training can yield meaningful improvement in somatosensory and sensory motor function (Joshua. et al., 2015). Another study has shown positive position error at 15⁰ and 30⁰ when multi station proprioceptive exercises were given along with improvement in the VAS score. (Srinivas et al., 2012). Yet another study was conducted to find the effect of proprioceptive training on joint reposition sense on balance in athletes with knee injury the results of the study stated that proprioceptive exercise training has favourable effect on balance and joint position sense (Gajanana et al., 2013). There is a close interaction between proprioception and muscle strength (Felson et al., 2009) and there is high

correlation found between decreased proprioception of knee joint with knee pain (Kramer et al., 2013). All the above mentioned studies support the findings of the present study that proprioceptive exercises are effective in treating OA knee patients.

In the present study, between group comparisons demonstrated proprioceptive exercises along with conventional treatment to be better than calisthenic exercise with conventional treatment for VAS, proprioceptive angle at 45⁰ and functional reach scale in terms of pain, proprioception and balance parameters respectively. Conventional physiotherapy was provided for both the experimental groups. Hence, the study provides an indirect evidence to support the effect of proprioceptive exercises to be better than light intensity calisthenic exercises. The difference between groups can be explained by the fact that in the present study low intensity of calisthenic exercises were prescribed. Further, the inclusion of moderate to high intensity calisthenics might have resulted in more significant results. Yet another explanation could be the characteristics of calisthenic exercises, which are a form of dynamic exercise where a variety of rhythmical movements like twisting, bending, kicking are performed using one's own body weight as resistance. These exercises are mainly said to improve strength and flexibility (Diego et al., 2015; Ozer et al., 2012 ; Sekir 2005). The better improvement in proprioception than calisthenic could be due to the reason that the proprioceptive exercises include unpredictable movements which teach our body to control the position of the joints (Srinivas et al., 2012; Lin et al., 2013; Demirhan et al., 2005). Moreover, proprioceptive exercises are specific for the specific problems associated with degenerative joint diseases where there is affection of proprioceptive functions. Since proprioceptive exercises bring about synchronous activities of knee muscle that might have lead to better improvement inbalance and proprioception of the study subjects.(Lin et al., 2013). Although few exercises appear to be similar in both the exercise groups (e.g. leg swings vs leg kicks, one leg heel raise vs calf raises and one leg knee squats vs knee bends), they are different due to the fact that the exercises were working on dynamic stability in proprioceptive exercise group than calisthenic exercises(Iwamoto et al., 2009). The exercises were assisted by the therapist in proprioceptive group where exercises were to be done with unilateral limb stance while in the calisthenic group the exercises were resisted with one's own body weight with double limb support.The exercises also varied in the number of repetitions which were more in proprioceptive exercise group and another reason could be that calisthenic exercises were given continuously with no rest periods which could have allowed fatigue to set in the subjects. Thus, in the present study the statistical analysis supports the alternative hypothesis which states that proprioceptive exercise are more efficient than calisthenic exercise in improving pain, balance, proprioception and functions in subjects with chronic osteoarthritis of knee. The present study had a few limitations. Effects of only 10 sessions of supervised exercises were studied as it's difficult to maintain follow up of patients for several weeks. Further, long term follow up was not monitored due to time constraint of study. Yet another limitation of the study was that the study lacked control group where only conventional exercises could have been given. A comparison of calisthenics with control group would give better picture of whether calisthenics has better effects over conventional exercises. Lastly, low intensity calisthenics were given since the study population in the present study has degenerative changes which cautions from prescription of high intensity calisthenics. Hence, future scope of the study moderate intensity calisthenics should be studied.

Conclusion

On the basis of the current results, it can be concluded that both proprioceptive and calisthenic exercises are effective for pain, proprioception, balance and functions in chronic knee osteoarthritis when prescribed along with basic conventional physiotherapy. Hence, light intensity Calisthenic exercises are effective and can be recommended as an adjunct to conventional physiotherapy for the patients with Osteoarthritis knee.However, when calisthenic exercise group was compared to

proprioceptive exercise group, it proved that proprioceptive exercises were superior to calisthenic exercises in reducing pain and improving proprioception and balance when prescribed along with conventional physiotherapy.

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