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Effectiveness of Yoga Therapy with the Therapeutic Exercises on Walking Pain, Tenderness, Early Morning Stiffness and Disability in Osteoarthritis of the Knee Joint - A Comparative Study

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Abstract

Objectives: To evaluate the efficacy of yoga therapy with the therapeutic exercises in Osteoarthritis (OA) of the knee joints.

Design: This was a prospective randomized active controlled trial. 250 participants with OA knees between 35-80 years (Yoga 59.56±9.54) and (Control 59.42±10.66) from the outpatient department of Ebnezar Orthopedic Center, Bengaluru, were randomly assigned to receive yoga therapy or therapeutic exercises after transcutaneous electrical stimulation and ultrasound treatment (20 minutes per day). Both the groups practised supervised interventions (40 minutes per day) for three months. 118 (yoga) and 117 (control) were available for the final analysis.

Results: There were significant differences within (Wilcoxon's, $p<0.001$) and between the groups (Mann Whitney 'U', $p<0.001$) on all the variables with better improvements in the yoga than the control groups. Walking pain in the yoga (37.3%, 64.9%) and control (24.9%, 42 %), joint tenderness in yoga (52.3%, 86.1%) and control (28%, 57.1%), early morning stiffness decreased more ($p<0.001$) in yoga (post 1=68.6% and post 2= 98.1%) than control group (post 1=38.6 %and post 2=71.6%) and knee disability in the yoga (59.7%, 83%) and control (32.7%, 53.6 %) , all improved better in the yoga than the control groups on the 15th and 90th day respectively.

Conclusion: Integrated approach of yoga therapy is better than therapeutic exercises as an adjunct to transcutaneous electrical stimulation and ultrasound treatment in improving walking pain, tenderness, early morning stiffness and knee disability in patients with OA knees.

Keywords: Osteoarthritis; Yoga; Walking pain; Tenderness; Stiffness; Knee disability

Introduction

Osteoarthritis is the most common type of arthritis and is characterized primarily by articular cartilage degeneration and a secondary peri-articular bone response [1,2]. Worldwide the prevalence rate of OA is 20% for men and 41% for women and it causes pain or dysfunction in 20% of the elderly [3]. In India, OA is the 2nd most common rheumatological problem and has a prevalence rate of 22 to 39 % [4]. Relieving pain and stiffness, and improving physical function are the important goals of present day therapy Nonopioid analgesics and anti-inflammatory drugs which form the mainstay of drug treatment do reduce [5,6] ain and inflammation but their long-term use is associated with many adverse effects [7,8].

The need for safer treatment of osteoarthritis has led to research into many alternative and complementary therapies [9]. There are several RCTs that have used non-pharmacological interventions for OA knees. In a Meta-analysis of 36 randomized placebo-controlled trials (RCT's) on 1391 patients, manual acupuncture, static magnets and ultrasound therapies did not offer statistically significant short-term pain relief over placebo, while pulsed electromagnetic fields offered a small reduction in pain. Transcutaneous electrical nerve stimulation (TENS, including interferential currents), electro-acupuncture (EA) and low level laser therapy (LLLT) offered clinically relevant pain relieving effects which seemed to persist for at least 4 weeks. This review by Bjordal et al concluded that physiotherapy modalities at the most offer only short term relief of pain and hence add on therapies like exercises, acupuncture etc, may be beneficial [10].

The beneficial effects of yoga on OA hands have been reviewed by Garfinkel et al. [11] these authors studied effects of 10 weeks of supervised yoga in a RCT on 25 subjects and showed significant reduction in pain, tenderness and improved range of motion of fingers [12]. In another pilot study on 11 patients with OA knees they showed reduction in pain and disability [13]. Ranjita showed 28-45% improvement in pain and mobility after one week of intensive residential integrated yoga therapy for OA knees [14]. There are studies on add-on exercise to physiotherapy [15] and acupuncture to physiotherapy as adjuvant therapies [16] but there are no studies on add-on yoga to physiotherapy. Also there are no RCTs that have looked at the effect of yoga on OA knees with active intervention for the control group. Hence the present study was planned to study the effects of yoga as an adjunct to physiotherapy in the treatment of OA knees.

Material and Methods

250 patients with OA knees from the outpatient department of Ebnezar Orthopedic Center, Bengaluru were recruited for the study.

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Table 1 shows the baseline characteristics which were similar between groups on all variables ($p>0.05$, Mann Whitney test for pre values). A sample size of 250 was obtained on G power software by fixing the alpha at 0.05 powered at 0.8 and an effect size of 0.379 considering the mean and SD of an earlier study [17].

250 Patients were of both genders in the age group of 35-80 years (YOGA 59.6±8.2; CONTROL 59.4±10.7) with OA of the knee (one or both joints) satisfying the ACR guidelines [18] for diagnosis were included. The inclusion criterions were (i) persistent pain for 3 months prior to recruitment (ii) moderate to severe pain on walking (iii) radiologic grading [19] of II to IV in X-rays taken within 6 months prior

	Conventional Physiotherapy- was carried out only at the center for 15 days which included • TENS- 10 mins • Ultrasound- 10 mins		20.0 mins
	Integrated yoga practice- This was made to practice by the patient at the center for 40 mins for 15 days after the conventional physiotherapy and later advised to continue at home for the next 3 months. This included the following practices:		40.0 mins
	Shithilikarana vyayama (Loosening Exercises):		10.0 mins
1.	**Foot And Ankle loosening practices**		
	➢ Passive rotation of each toe (Clockwise and anticlockwise)	10 rounds	1.0 min
	➢ Toe bending	10 rounds	0.5 min
	➢ Passive rotation of ankle (Clockwise and anticlockwise)	10 rounds	0.5 min
	➢ Ankle bending	10 rounds	0.5 min
	➢ Ankle rotation (Clockwise and anti-clockwise)	10 rounds	0.5 min
2.	**Knee loosening practices**		
	➢ bending the knee in prone position		1.0 min
	➢ knee bending – Both Sides	10 rounds	0.5 min
	➢ Knee rotation – Both sides	10 rounds	0.5 min
	➢ passive patella rotation		0.5 min
3.	**Hip and Waist loosening practices**		
	➢ Half Butterfly	10 rounds	1.5 Min
	➢ Full Butterfly	10 rounds	1.5 Min
	➢ Hip rotations (Both Internal and External)	10 rounds	0.5 min
4.	**Upper Limbs loosening practices**		
	➢ Finger loosening	10 rounds	1.5 Min
	➢ Wrist loosening	10rounds	1.5 Min
	➢ Wrist rotation (Clockwise and anticlockwise)	10 rounds	0.5 min
5.	**Neck loosening practices**		
	➢ Forward and backward bending	10 rounds	1.0 min
	➢ Neck rotation (Both Clockwise and anticlockwise)	10 rounds	0.5 min
6.	**Relaxation – Instant**		2.0 mins
7.	**Strengthening Exercises (sakti vikaasaka suksma vyayama)**		5.0 mins
	➢ Back exercises (kati sakti vikaasaka)	5 rounds	0.5 min
	➢ Thigh exercises (jangha sakti vikaasaka)	5 rounds	0.5 min
	➢ straight leg raise breathing- single and both legs	10 rounds	1.5 mins
	➢ Knee Cap Tightening – single and both legs	10 rounds	2.0 mins
	➢ Ankle tightening exercises	5 rounds	0.5 min
8.	**Quick relaxation technique (QRT) -** consists of 3 phases involving observing the abdominal movements, synchronizing it with breathing and chanting of 'A' kara, wherein 'A' is the mantra.		3.0 mins
9.	**Yogasanas**		10.0 mins
	A. Standing Asanas		
	➢ Tadasana		
	➢ Ardha Kati Chakrasana		
	➢ Ardha Chakrasana		
	➢ Prasarita padahastasana		
	B. Lying Asanas		
	➢ Bhujangasana		
	➢ Shalabasana		
	➢ Viparita Karani		
10.	**Deep Relaxation Technique**(DRT)- is a 3 phase guided relaxation technique with relaxation from toes to the head, feeling of letting go, chanting OM and feeling of limitless expansion through visualization.		5.0 mins
11.	**Nadi Shudi Pranayama-** Nadishuddhi Pranaayama is a slow rhythmic technique of alternate nostril breathing involving the phases of inhalation and exhalation using nasika mudra.		3.0 mins
12.	**OM Meditation-** is done seated in any comfortable meditative posture repeating the syllable OM mentally.		2.0 mins

Table 1: Yoga Module for OA Knees.

to entry (iv) those fully ambulant, literate and willing to participate in the study. Those with (i) Grade I changes in the x-rays (ii) acute knee pain (iii) secondary osteoarthritis due to rheumatoid arthritis, gout, septic arthritis, tuberculosis, tumor, trauma or hemophilia and (iv) those with major medical or psychiatric disorders were excluded.

The study was approved by the Institutional Review Board (IRB) and ethical committee of SVAYSA University. Signed informed consent was obtained from all the participants.

Design

This was a prospective randomized parallel active controlled study on patients with OA knees in the age range of 35 to 80 years. Patients attending the outpatient department of Ebnezar Orthopedic Center who satisfied the inclusion criteria were recruited for the study. After the initial screening for selection criteria they were assigned to either yoga or control group. A computer generated random number table (www.randomization.com) was used for randomization. Numbered envelopes were used to conceal the sequence until the intervention was assigned. Both groups were given conventional physiotherapy using transcutaneous electrical stimulation and ultrasound for 2 weeks.

Both the groups had supervised practices at the center (40 minutes per day) after physiotherapy (20 minutes per day) for two weeks. The yoga classes were conducted in the basement of the center where one hall was exclusively dedicated for yoga therapy. The study group was taught integrated yoga and the control group the non-yogic therapeutic exercises by certified therapists all trained at Yoga University, SVYASA, and Bangalore. After this they were asked to practice daily at home for the next twelve weeks. The patients were asked to mark the practices daily in the diary provided for this purpose after their home practice. Compliance was supervised by telephone calls once in 3 days and a weekly review was conducted once a week for 12 weeks. The daily review cards were checked for the regularity and doubts if any were clarified. This along with their clinical progress was checked and documented at every visit. All the assessments were carried out on the 1st, 15th and 90th day by the therapists.

Blinding and masking

As this was an interventional study, double blinding was not possible. The answer sheets of the questionnaires were coded and analyzed after the study was completed. The statistician who did the randomization, data analysis and the researcher who carried out the assessments were blinded to the treatment status of the subjects.

Intervention for Yoga group

The daily routine practiced at the center in the yoga group included 40 minutes of integrated yoga therapy practice after 20 Minutes of physiotherapy with transcutaneous electrical stimulation and ultrasound for 2 weeks. The integrated yoga therapy practice included shithilikarana vyayamas (loosening practices), sakti vikasaka (strengthening practices) followed by yogasanas and relaxation techniques with devotional songs. Later patients were advised to continue the integrated yoga therapy practice for 40 minutes at home for the next 10 weeks. The concept used to develop a specific module of an integrated approach of yoga therapy for knee pain were taken from the traditional yoga scriptures (*patanjali yoga sutras, yoga vasishtha* and *upanishads*) that highlight a holistic life style for positive health at physical, mental, emotional and intellectual levels. [20] Yoga is defined as the mastery over the modifications of mind (*chitta vritti nirodhah*-definition of yoga by *patanjali*). It helps to remove the unnecessary surges of neuromuscular activation resulting from heightened stress responses that may contribute to aging [21] (Table 2).

The daily routine included a 40 minutes practice as follows:

- *Yogic sukshma vyayamas* (Loosening and strengthening practices): These are safe, rhythmic, repetitive stretching movements synchronized with breathing. These practices mobilize the joints and strengthen the peri-articular muscles.
- *Relaxation techniques* Three types of guided relaxation techniques were interspersed between the physical practices of *sukshmavyayamas* and *asanas*.
- *Asanas (physical postures)* Asanas are featured by effortless maintenance in the final posture by internal awareness. We selected asanas in standing, supine and prone positions that would relax and strengthen the knee joints.
- *Pranayama* The practice of voluntary regulated breathing while the mind is directed to the flow of breath is called *Pranayama* These practices promote autonomic balance through mastery over the mind [22].
- *Meditation* Patanjali defines meditation (*dhyana*) as effortless flow of a single thought in the mind without distractions (*pratyaya ekataanata dhyanam*). This has been shown to offer physiological benefits through alertful rest to the mind body complex [23].
- *Lectures and Counseling* Yogic concepts of health and disease, *yama, niyama, bhakti yoga, Jnana yoga* and *karma yoga* were presented in the theory classes. These sessions were aimed at understanding the need for life style change, weight management and prevent early aging by yogic self management of psychosocial stresses.

Intervention for control group

The daily routine practiced at the center in the control group included 40 minutes of therapeutic exercises after 20 minutes of physiotherapy with transcutaneous electrical stimulation and ultrasound for 2 weeks. These therapeutic exercises included loosening and strengthening practices for the all the joints of the upper and lower limbs, brief period of rest, specific knee practices and supine rest followed by light music. Later patient was advised to continue the therapeutic exercise practice of 40 minutes at home for the next 12 weeks.

Outcome variables

Pain while walking (WNRS) Patients were asked to mark the severity of their pain experienced while walking in the past few days on a numerical pain rating scale. For this purpose a 10 cm line drawn in the center of a white sheet with '0' as 'nil pain' and '10' as 'worst possible pain' was used. [24] Separate sheets were used during each assessment.

Tenderness: Knee tenderness was graded by the clinician using the following key: Grade 1 - tenderness on deep palpation, 2 - patient winces on pressure, 3 - patient winces and withdraws and 4 - patient does not allow the examiner to touch [25].

Early morning stiffness in minutes as reported by the patients during clinical interview was documented.

Knee Disability Score This was assessed by WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index Score for

	Conventional Physiotherapy- was carried out only at the center for 15 days which included • TENS- 10 mins • Ultrasound- 10 mins		20.0 mins
	Therapeutic Practices- This was made to practice by the patient at the center for 40 mins for 15 days after the conventional physiotherapy and later advised to continue at the home for next 3 months. This included the following practices:		40.0 mins
	Loosening Exercises		10 mins
1.	**Foot And Ankle**		
	➢ Passive rotation of the toes (Each toe Clockwise and anticlockwise)	10 rounds	0.5 mins
	➢ Passive rotation of the ankle (Both Clockwise and anticlockwise)	10 rounds	0.5 mins
	➢ Toe bending	10 rounds	0.5 mins
	➢ Ankle bending	10 rounds	0.5 mins
	➢ Ankle rotation (Clockwise and anti-clockwise both sides)	10 rounds	0.5 mins
2.	**Knee**		
	➢ Knee bending – Both Sides	10 rounds	0.5 min
	➢ Knee rotation – Both sides	10 rounds	0.5 min
3.	**Hip and Waist loosening practices**		
	➢ Half Butterfly	10 rounds	1.5 Min
	➢ Full Butterfly	10 rounds	1.5 Min
	➢ Hip rotations (Both Internal and External)	10 rounds	0.5 min
4.	**Upper Limbs loosening practices**		
	➢ Finger loosening	10rounds	1.5 Min
	➢ Wrist loosening	10rounds	1.5 Min
	➢ Wrist rotation (Both Clockwise and anticlockwise)	10 rounds	0.5 min
	➢ Elbow loosening	5 rounds	0.5 min
	➢ Arm loosening - Forward and backward movements	10 rounds	0.5 min
5.	**Neck loosening practices**		
	➢ Forward and backward bending	10 rounds	0.5 min
	➢ Sideward bending	10 rounds	0.5 min
	➢ Sideward tilting	5 rounds	0.5 min
	➢ Neck rotation (Both Clockwise and anticlockwise)	5 rounds	0.5 min
6.	**Quick pause**		2.0 mins
7.	**Strengthening Exercises**		5.0 mins
	➢ Palm Exercises	5 rounds	0.5 min
	➢ Elbow Exercises	10 rounds	0.5 min
	➢ Arm exercises	5 rounds	0.5 min
	➢ Back exercises	5 rounds	0.5 min
	➢ Thigh exercises	5 rounds	0.5 min
	➢ Calf exercises	5 rounds	0.5 min
8.	**Rest**		3 mins
9.			15.0 mins
	➢ Flexion and Extension with and without resistance		3 mins
	➢ Knee Cap tightening - Self and against small pillow		3 mins
	➢ Straight Leg raising – single and both – 30/60/90 degrees		5 mins
	➢ Cycling		4 mins
10.	**Supine Rest**		5.0 mins

Table 2: Control Module for OA Knees.

Knee Joint) that consists of 24 questions under three domains i.e. Pain (5 questions), Physical functions (17 questions), and Stiffness (2 questions). Each item was scored by the patient on a 5 point scale (0-4). Total WOMAC score is the sum of the scores on all items. Higher the score, more severe is the disability. This multi-dimensional questionnaire has well defined reliability, test-retest reliability, content and construct validity, at Cronbach's alpha of 0.88 to 0.95 and concordance correlation coefficient of 0.85 to 0.94 [26] (Table 3).

Statistical methods

The data was analyzed using SPSS Version 16. The base line values of the two groups were checked for normal distribution by Shapiro Wilk Test. Baseline matching was checked by Mann Whitney test. Wilcoxon's signed rank test and Mann -Whitney 'U' test were used for assessing 'within' and 'between' group differences respectively.

Results

There were 7 dropouts in the study group and 8 in the control group. Table 4 shows the results within the yoga group on the 15th and 90th day. Table 5 shows the results within the control group on the 15th and 90th day. Table 6 shows the results between the yoga and control groups.

Walking pain (WNRS)

The baselines were matched for both groups and data were not normally distributed. Pain while walking (Numerical rating scale)

CHARACTERISTICS		YOGA (N=125)	CONTROL (N=125)
AGE	(M±SD)	59.56±8.18	59.42±10.66
SEX	Males	37	39
	Females	88	86
OCCUPATION	Skilled workers	28	32
	Semi-skilled workers	34	31
	Unskilled workers	3	5
	Others	60	57
DURATION OF THE DISEASE	<1yr	62	59
	1-2yrs	39	40
	>2yrs	24	26
ASSOCIATED DISEASES			
Diabetes		22	16
Hypertension		30	19
Overweight/Obesity		98	73
Osteoporosis		78	67
Others		26	30

Table 3: Demographic Data.

reduced better (p<0.001) in yoga (37.3%-yoga, 24.9%-control) on 15th and 90th day (64.9% yoga, 42 %-control). There was a significant difference in walking pain within (Wilcoxon's, p<0.001) and between the groups (Mann Whitney 'U' test, p<0.001) after the intervention with higher effect size in yoga than the control group.

Tenderness showed a significant difference within (Wilcoxon's, p<0.001) and between the groups (Mann Whitney 'U' test, p<0.001) with joint tenderness in yoga (52.3%, 86.1%) and control (28%, 57.1%), after the intervention with higher effect size in yoga than the control group.

Early morning stiffness

Morning stiffness decreased more (p<0.001) in yoga (post 1=68.6% and post 2= 98.1%) than control group (post1=38.6 %and post 2=71.6%). There was a significant difference in early morning stiffness within groups (Wilcoxon's, p<0.001) and between groups (Mann Whitney, p<0.001) after the intervention at both points in time with higher effect sizes in yoga than control group.

Knee disability score (WOMAC)

Western Ontario and McMaster Universities Osteoarthritis Index Score for Knee disability improved by 83.02% in the yoga group and 53.6% in the control group at 3 months. Walking time improved better in the yoga (52.8%) than the control group (21.5%). There was a significant difference in knee disability within (Wilcoxon's, p<0.001) and between the groups (Mann Whitney 'U' test, p<0.001) after the intervention with higher effect size in yoga than the control group.

Discussion

This randomized two armed parallel controlled trial on 250 participants included patients of both genders in the age group of 35 to 80 years with osteoarthritis of the knee joints. Results showed significantly better improvement in yoga than control group on all variables (p<0.001 Mann Whitney) i.e. walking pain, knee flexion, walking time, tenderness, swelling, crepitus and knee disability.

Pain reduction

The reduction in walking pain observed in our study points to the beneficial effect of yoga as an add-on therapy to conventional physiotherapy practices. In a pilot study on OA knees, Kolasinski et al. [13] used a specific sequence of asanas based on the teachings of Iyengar for 8 weeks. They measured the pain by WOMAC with a significant reduction (p 0.04) in pain by 46.7%. In another pilot study on yoga for OA knees, Ranjita et al. [14] used a set of integrated yoga therapy program similar to our study in a non-residential camp set up for one week without any physiotherapy intervention. They showed a 40% reduction (from 6.59±2.24 to 3.97±2.44) in resting pain after yoga. In our study we added yoga after the standard physiotherapy which showed a reduction in walking pain scores by 37.3% and 65 % after 15 and 90 days respectively.

YOGA GROUP								
	VB	Pre & post	Mean ± SD	95% CI		ES	p-value	% Change
				LB	UB			
	WP	Pre	9.54±0.60	9.43	9.65	3.69		
		Po 1	5.98±0.92	5.81	6.15	5.82	<0.001	37.31
		Po 2	3.35±0.99	3.17	3.53	3.83	<0.001	64.88
	TN	Pre	3.55±0.58	3.44	3.65	3.31		
		Po 1	1.69±0.72	1.56	1.83	4.83	<0.001	52.39
		Po 2	0.49±0.63	0.37	0.60	2.41	<0.001	86.19
	EMS	Pre	16.47±5.22	15.51	17.42		2.41	
		Po1	5.17±3.97	4.44	5.89	<0.001	3.13	-68.6
		Po 2	0.31±1.27	0.07	0.54	<0.001	1.35	-98.1
	KDS	Pre	57.26±10.40	55.35	59.16	3.80		
		Po1	23.10±8.49	21.55	24.65	4.69	<0.001	59.65
		Po 2	9.72±4.87	8.83	10.61	2.35	<0.001	83.02

Abbreviations: WP-walking pain, TN-Tenderness, EMS-Early morning stiffness, KDS-knee disability score, Po1-Post(15th day),Po2-(90thday),SD-standard deviation,CI-confidence interval,LB-lower bound,UB-upper bound, ES-Effect size and %change-percentage change.

Table 4: Showing Results within Yoga Group.

CONTROL GROUP								
	VB	Pre & post	Mean ± SD	95% CI		ES	p-value	% Change
				LB	UB			
	WP	Pre	9.29±0.73	9.16	9.42	2.38		
		Po 1	6.98±1.09	6.78	7.18	2.78	<0.001	24.86
		Po 2	5.35±1.49	5.08	5.62	2.14	<0.001	41.98
	TN	Pre	3.36±0.70	3.2266	3.48	2.83		
		Po 1	2.42±0.66	2.29	2.53	3.92	<0.001	27.97
		Po 2	1.44±0.69	1.31	1.57	3.95	<0.001	57.14
	EMS	Pre	16.53±5.45	15.53	17.53		1.93	
		Po1	10.14±5.40	9.15	11.13	<0.001	3.11	-38.6
		Po 2	4.68±4.63	3.83	5.53	<0.001	2.18	-71.6
	KDS	Pre	59.61±11.3	57.52	61.70	1.81		
		Po1	42.74±13.67	40.21	45.26	2.33	<0.001	32.68
		Po 2	27.66±13.78	25.12	30.20	2.11	<0.001	53.59

Abbreviations: WP-walking pain, TN-Tenderness, EMS-Early morning stiffness, KDS-knee disability score, Po1-Post(15th day),Po2-(90thday),SD-standard deviation,CI-confidence interval,LB-lower bound,UB-upper bound, ES-Effect size and %change-percentage change.

Table 5: Showing Results within Control Group.

The baseline pain scores were much higher in our study (9.54±0.61) than Ranjita's study (6.59±2.24). This difference is because she recorded the resting pain and we documented the pain while walking. However, the degree of changes appears to be similar in all the three yoga studies (37 - 47 %). This may point to the efficacy of yoga when used with or without a session of physiotherapy before the practice of yoga.

Similar effects of pain reduction has been observed by Garfinkel et al. [27] in a RCT on yoga for carpal tunnel syndrome, wherein the mean NRS scores for pain decreased significantly (P =.02) from 5.0 to 2.9 mm. Tekur et al. [28] studied the efficacy of IAYT in patients with chronic low back pain which included several cases of spondylosis of the spine and documented 48.8 % reduction in NRS scores in the yoga group within one week of residential program without offering any physiotherapy intervention. Garfinkel et al. [12] looked at the effect of Iyengar yoga in OA hands. Pre-post difference in mean scores of 'pain during activity' in their study was similar (4.29) to our study (3.56 at 2nd week and 6.19 at 3 months). However, they did not observe significant difference between groups in tenderness, swelling or hand functions whereas these variables were significantly better in yoga than controls in our study.

Early morning stiffness

Haslock et al. [26] showed the beneficial effects of specific integrated yoga practices in patients with rheumatoid arthritis who had secondary OA in several joints. They observed better increase in hand grip strength (63%, left, 66% right) in yoga group than non yoga controls (8% left and 5% right) indicating reduced stiffness. Our study showed a reduction in early morning stiffness scores by 69 and 98% after 15 and 90 days respectively. None of the other yoga studies have noted morning stiffness as an outcome variable.

Knee disability score

In Kolasinski's study on OA knees [13] there was a reduction in WOMAC knee disability score by 44 % (p 0.04). In our study the disability reduced by 60% to 83% on the 15th and 90th day in the yoga group. In Ranjita's [14] study of one week of intensive yoga without physiotherapy there was improvement in performance oriented mobility (45%) and also in 'Timed up and Go' test (28 % in 'number of steps' and 30% in 'time taken'). Haslock et al. [29] in their controlled study on IAYT for patients with severe degree of rheumatoid arthritis who had secondary OA also showed significant reduction in pain and functional disability with 63% (left) and 66% (right) increase in hand grip strength in yoga group as compared to an increase of 5 & 8% in their control group.

Mechanisms

Activation of pain fibers (unmyelinated and small myelinated) found in the joint capsules, ligaments, synovium, bone and the outer edges of the menisci, increased intramedullary tension, subchondral micro-fractures, osteophyte formation and flexion contractures due to OA changes are the major factors that cause pain [30]. Decreased

BETWEEN GROUPS				
	VARIABLES	Pre & post	ES	p-value
1.	WP	Pre		0.024
		Po 1	0.99	<0.001
		Po 2	1.58	<0.001
2.	TN	Pre		0.14
		Po 1	1.06	<0.001
		Po 2	1.43	<0.001
3.	EMS	Pre		2.742
		Po 1	1.05	<0.001
		Po 2	1.28	<0.001
4.	KDS	Pre		0.25
		Po 1	1.73	<0.001
		Po 2	1.75	<0.001

Abbreviations: WP-walking pain, TN-Tenderness, EMS-Early morning stiffness, KDS-knee disability score, Po1-Post(15th day),Po2-(90thday) and ES-Effect size.

Table 6: Showing Results between Grops.

muscular stamina and muscle spasm are additional factors that can aggravate pain and disability. The actual experience of pain is a psychological phenomenon that has several additional central processes that include affective, behavioral and cognitive factors [31].

The multi-factorial approach of yoga comprises practices that involve not only physical practices (asanas) that may provide benefits locally at the joint level but includes breathing *(pranayama)*, meditation (*dharana and dhyana*), introspective intellectual (*jnana yoga*) and emotion management (*bhakti yoga*) practices that promote healthy behavioral and life style changes. Muscle strengthening is the key component of exercises for osteoarthritis since muscle weakness is one of the major causes for pain and disability. Studies have demonstrated the efficacy of exercise programs in improving muscle strength, flexibility, mobility and coordination in patients with osteoarthritis of knee and hip joints [32-34]. There are several studies that have demonstrated better muscular stamina and strength [35] as well as steadiness and flexibility [36] after yoga in normal volunteers. This has been observed in patients with rheumatoid arthritis too [29]. Right way of positioning the body in space at rest and during motion achieved through introspective body awareness differentiates yoga from physical exercises. Stress reducing effect of yoga seems to be the other major mechanism of its efficacy in pain management in these patients [37].

Good sample size, randomized controlled design, active supervised intervention for the control group for the same duration as the experimental group and follow up for three months with good compliance (6 % dropouts) are the strengths of this study. Maximum number of patients had associated co-morbidities and showed a better reduction in yoga group. Study included patients with both the knees and single knee affected and both showed the same effect with the treatment. The severity of the ailment was same in both the groups and also showed the reduction in the medication score was observed but not recorded. The results of this study have shown marked differences on all the variables between the groups and thus offer a strong evidence for incorporating this yoga module for the management of OA knees by the clinicians.

The study was on a select group who presented to a specialty orthopedic center and hence is not generalizable. A longer follow up of ≥ 12 months is necessary to check for long term efficacy and long term acceptability. Studies using MRI and biochemical variables may throw a better light on the mechanisms.

Conclusions

Adjunctive program of integrated approach of yoga therapy for OA knees reduces walking pain, tenderness, early morning stiffness and disability better than the therapeutic exercises. It thus offers a good value addition non-pharmacological intervention in the management of OA knees.

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