Original Article

Effect of an integrated approach of yoga therapy on quality of life in osteoarthritis of the knee joint: A randomized control study

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ABSTRACT

Aim: This study was designed to evaluate the efficacy of addition of integrated yoga therapy to therapeutic exercises in osteoarthritis (OA) of knee joints.

Materials and Methods: This was a prospective randomized active control trial. A total of t participants with OA of knee joints between 35 and 80 years (yoga, 59.56 ± 9.54 and control, 59.42 ± 10.66) from the outpatient department of Dr. John's Orthopedic Center, Bengaluru, were randomly assigned to receive yoga or physiotherapy exercises after transcutaneous electrical stimulation and ultrasound treatment of the affected knee joints. Both groups practiced supervised intervention (40 min per day) for 2 weeks (6 days per week) with followup for 3 months. The module of integrated yoga consisted of *shithilikaranavyayama* (loosening and strengthening), *asanas*, relaxation techniques, *pranayama*, meditation and didactic lectures on *yama, niyama, jnana yoga, bhakti yoga*, and *karma yoga* for a healthy lifestyle change. The control group also had supervised physiotherapy exercises. A total of 118 (yoga) and 117 (control) were available for final analysis.

Results: Significant differences were observed within ($P < 0.001$, Wilcoxon's) and between groups ($P < 0.001$, Mann–Whitney *U*-test) on all domains of the Short Form-36 ($P < 0.004$), with better results in the yoga group than in the control group, both at 15th day and 90th day.

Conclusion: An integrated approach of yoga therapy is better than therapeutic exercises as an adjunct to transcutaneous electrical stimulation and ultrasound treatment in improving knee disability and quality of life in patients with OA knees.

Key words: Knee disability; osteoarthritis; SF-36; yoga.

INTRODUCTION

Osteoarthritis (OA) is the second most common rheumatological problem in India and has a prevalence rate of 22–39%.[1] It is characterized primarily by articular cartilage degeneration and a secondary periarticular bone response.[2,3] Worldwide prevalence rate of OA is 20% for men, 41% for women, and it causes pain or dysfunction in 20% of the elderly.[4] Relieving pain stiffness and improving physical functions are the important goals of the present day therapy.[5,6]

The management of OA is still far from optimal, because the medications currently available provide limited symptomatic relief and are fraught with a number of side-effect.[7] It is increasingly recognized that a key outcome measure for any health-care intervention for OA is the change in health-related quality of life (QOL).[8,9] Although OA itself is not a life-threatening disease, QOL can significantly deteriorate with pain and loss of mobility causing dependence and disability.[10] Health-related QOL may be measured by disease-specific and generic health status questionnaires. Western Ontario and McMaster Universities Osteoarthritis Index Score (WOMAC) is used to measure specific functional disability and SF-36 is used to measure general

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health status that includes assessment of emotional functioning, energy level, and social functioning in addition to functional disability assessment. Aglamiş *et al*,[11] Foley *et al*,[12] and Diracoglu *et al*.[13] observed greater increases in the SF-36 after the exercise program of various durations for patients with OA knees. Kirkley *et al*.[14] showed that in patients assigned to arthroscopic surgery, there was no improvement with health-related QOL. In a study by Tekur *et al*.[15] the role of yoga in the improvement of QOL of patients with chronic low backache was discussed, and she showed that in the yoga group, there was significant improvement in the scores of WHOQOL (WHO's Quality of life) brief on all domains. In a study by Sudheer *et al*.[16] about the role of yoga about QOL in normal volunteers, 28% in physical, 16% in psychological, 10.17% in social, and 8.8% in the environmental domain changed significantly after shifting to the control intervention in the second week.

There are no studies that have looked at disability and QOL measures in patients with OA knees after integrated yoga therapy involving loosening, strengthening, asanas, etc. Hence, this study was planned with an aim to assess the effects of the integrated approach of yoga therapy on QOL using a generic health-status tool involving SF-36 in patients with OA knee.

MATERIALS AND METHODS

A total of t patients with OA knees from the outpatient department of Dr John's Orthopedic Center, Bengaluru, were recruited for the study. 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] A total of t of both genders in the age group of 35–80 years (59.56 ± 8.18) in the yoga group and (59.42 ± 10.66) control group with OA knees (one or both joints) satisfying theAmerican College of Rheumatology (ACR) Guidelines[18] for diagnosis were included. The inclusion criteria were (i) persistent pain for 3 months prior to recruitment, (ii) moderate-to-severe pain on walking, (iii) Kellegren and Lawrence[19] radiologic grading of II–IV in X-rays taken within 6 months prior to entry, and (iv) those fully ambulant, literate, and willing to participate in the study. Those with (i) grade I changes in -ray, (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 SVYASA (Swami Vivekananda Yoga Anusandhana Samsthana) University. Signed informed consent was obtained from all the participants.

Design

This was a prospective randomized parallel active control study on patients with OA knees in the age range of 35-80 years. Patients attending the outpatient department of Dr John's Orthopedic Center who satisfied the inclusion criteria were recruited for the study. After the initial screening for selection criteria, they were assigned to either the yoga group 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 the conventional physiotherapy using transcutaneous electrical stimulation and ultrasound for 15 days.

Both groups had supervised practices at the center for 40 min daily (6 days/week) after physiotherapy (20 min) for 2 weeks. The yoga classes were conducted in the basement of the hospital where one hall is exclusively dedicated for yoga therapy. The study group was taught integrated yoga and the control group was taught the non-yogic physiotherapy exercises by certified therapists. After this, they were asked to practice daily at home for the next 3 months. Compliance was supervised by telephone calls once in 3 days and a weekly review was conducted once a week for 3 months. The daily review cards were checked for the regularity and doubts if any were clarified. The evaluation was conducted by the senior research fellow. All patients were asked to tick the practices daily after the home practice in the diary provided for the purpose; at every visit their clinical progress and therapy received on the day were documented. All assessments were carried out on 1st, 15th, and 90th days.

Blinding and masking

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

Intervention for the yoga group

The daily routine practiced at the center in the yoga group included 40 min of integrated yoga therapy practice after 20 min of physiotherapy with transcutaneous electrical stimulation and ultrasound for 2 weeks [Table 1]. The integrated yoga therapy practice included shithilikaranavyayamas (loosening practices), saktivikasaka (strengthening practices) followed by yogasanas and relaxation techniques with devotional songs. Later patients were advised to continue the

Table 1: Yoga module for osteoarthritis knees

Conventional physiotherapy was carried out only at the center for 15 days which included		20.0 min
• TENS: 10 min		
• Ultrasound: 10 min		
Integrated yoga practice: This was made to practice by the patient at the center for 40 min 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 min
Shithilikaranavyayama loosening exercises:		10.0 min
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 (dorsiflexion and plantar flexion)	10 rounds	0.5 min
• Active 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 (made the patient to do by themselves)		0.5 min
3. Hip and waist loosening practices		
• Half butterfly	10 rounds	0.5 min
• Full butterfly	10 rounds	0.5 min
• Hip rotations (both internal and external)	10 rounds	0.5 min
4. Upper limbs loosening practices		
• Finger loosening	10 rounds	0.5 min
• Wrist loosening	10 rounds	0.5 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. IRT: This is a 17 step relaxation technique done by contracting the muscles of whole body starting from the toes to the forehead in a sequential manner and relaxing completely by letting go		2.0 min
7. Strengthening exercises (sakti vikaasaka suksmavyayama)		5.0 min
• Back exercises (katisaktivikaasaka)	5 rounds	0.5 min
• Thigh exercises (janghasaktivikaasaka)	5 rounds	0.5 min
• Straight leg raise breathing: single and both legs	10 rounds	1.5 min
• Knee cap tightening: single and both legs	10 rounds	2.0 min
• Ankle tightening exercises	5 rounds	0.5 min
8. Quick relaxation technique (QRT) consists of three phases involving observing the abdominal movements, synchronizing it with breathing and chanting of 'A' kara.		3.0 min
9. Yogasanas		10.0 min
A. Standing asanas		
• Tadasana		
• Ardha kati chakrasana		
• Ardha chakrasana		
• Prasaritapadahastasana		
B. Standing asanas		
• Bhujangasana		
• Shalabasana		
• ViparitaKarani		
10. Deep relaxation technique (DRT) is a three-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 min
11. Nadishuddhi pranayama - Nadishuddhi Pranayama is a slow rhythmic technique of alternate nostril breathing involving the phases of inhalation and exhalation using nasika mudra.		3.0 min
12. OM meditation is done seated in any comfortable meditative posture repeating the syllable OM mentally.		2.0 min

integrated yoga therapy practice for 40 min 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 was taken from the traditional yoga scriptures (*patanjali yoga sutras, yoga vasishtha*, and *upanishads*) that highlight a holistic lifestyle for positive health at physical, mental, emotional, and intellectual levels.[20] Yoga is defined as the mastery over the modifications of mind (*chittavrittinirodhah*—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] The daily routine included a 40 min practice as follows:

- Yogic sukshmavyayamas (loosening and strengthening practices): These are safe, rhythmic, repetitive stretching movements synchronized with breathing. These practices mobilize the joints and strengthen the periarticular 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 like OM in the mind without distractions (*pratyayaekataanatadhyanam*). 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 lifestyle change, weight management, and prevent early aging by yogic self-management of psychosocial stresses.

Intervention for the control group

The daily routine practiced at the center in the control group included 40 min of therapeutic exercises after 20 min of physiotherapy with transcutaneous electrical stimulation and ultrasound for 2 weeks [Table 2]. These therapeutic exercises included loosening and strengthening practices for 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 min at home for the next 12 weeks.

Outcome variables

Short Form 36) was used to assess QOL after the intervention in both groups on day 15 and 90. SF-36 is one of the popularly used self-evaluation questionnaire for the assessment of general.[24] It contains 36 questions aimed at assessment of the participant's health under eight major categories: physical functioning, role limitations due to physical health, role limitations due to mental health, energy or fatigue, emotional well-being, social functioning, pain, and general health. The scores are then averaged accordingly under those headings.[25]

The increase in scores indicates better for domains physical functioning, role of limitations in physical health, role of limitations in emotional problems, social functioning, pain reduction, general health, and for domains fatigue and emotional well-being the decrease in scores indicates better QOL. The internal consistency of the SF-36 Health Survey Questionnaire as determined by Cronbachs was high and ranged from 0.72-0.94.

Statistical methods

The data were analyzed using SPSS Version 16. The baseline values of the two groups were checked for normal distribution by Shapiro–Wilk's test. Baseline matching was checked by the Mann–Whitney test. Wilcoxon's signed ranks test and MannWhitney *U*-test were used for assessing 'within' and 'between' groups differences, respectively.

Tables 1 and 2 show the interventions of both study and control groups. Table 3 shows the baseline characteristics which were similar between groups on all variables ($P > 0.05$, Mann–Whitney test for pre values).

Table 2: Control module for OA knees

Conventional physiotherapy was carried out only at the center for 15 days which included • TENS: 10 min • Ultrasound: 10 min		20.0 min
Therapeutic practices: This was made to practice by the patient at the center for 40 min 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 min
Loosening exercises		10.0 min
1. Foot and ankle		
• Passive rotation of the toes (each toe clockwise and anticlockwise)	10 rounds	0.5 min
• Passive rotation of the ankle (both clockwise and anticlockwise)	10 rounds	0.5 min
• Toe bending	10 rounds	0.5 min
• Ankle bending	10 rounds	0.5 min
• Ankle rotation (clockwise and anticlockwise both sides)	10 rounds	0.5 min
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	0.6 min
• Full butterfly	10 rounds	0.6 min
• Hip rotations (both internal and external)	10 rounds	0.5 min
4. Upper limbs loosening practices		
• Finger loosening	10 rounds	0.6 min
• Wrist loosening	10 rounds	0.6 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 min
7. Strengthening exercises		5.0 min
• 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 min
9. Specific knee practices		15.0 mins
• Flexion and extension with and without resistance		3 min
• Knee cap tightening self and against small pillow		3 min
• Straight leg raisingsingle and both —30°/60°/90°		5 min
• Cycling		4 min
10. Supine rest		5.0 min

RESULTS

The trial profile of the study is shown in Figure 1. There were seven dropouts in the study group and eight in the control group. Table 4 shows the results within the yoga group

Table 3: Demographic data

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		
<1 year	62	59
1–2 years	39	40
>2 years	24	26
Associated diseases		
Diabetes	22	16
Hypertension	30	19
Overweight/obesity	98	73
Osteoporosis	78	67
Others	26	30

of 15th and 90th day. Table 5 shows the results within the control group of 15th and 90th day, and Table 6 shows the results between the yoga and control groups.

Quality of life

Between and within group differences were highly significant on all domains of the SF-36 ($P < 0.001$) with better improvement in the yoga group than the control group on 15th day and 90th day.

Physical functioning

This measures all the physical activities including bathing or dressing. In the yoga group, the physical function ($P < 0.001$) increased from 12.03 ± 9.94 to 39.32 ± 11.24 and further to 67.50 ± 9.09 and in the control group from 12.82 ± 10.81 to 24.95 ± 13.93 and further to 50.94 ± 14.76 on 15th day and 90th days, respectively.

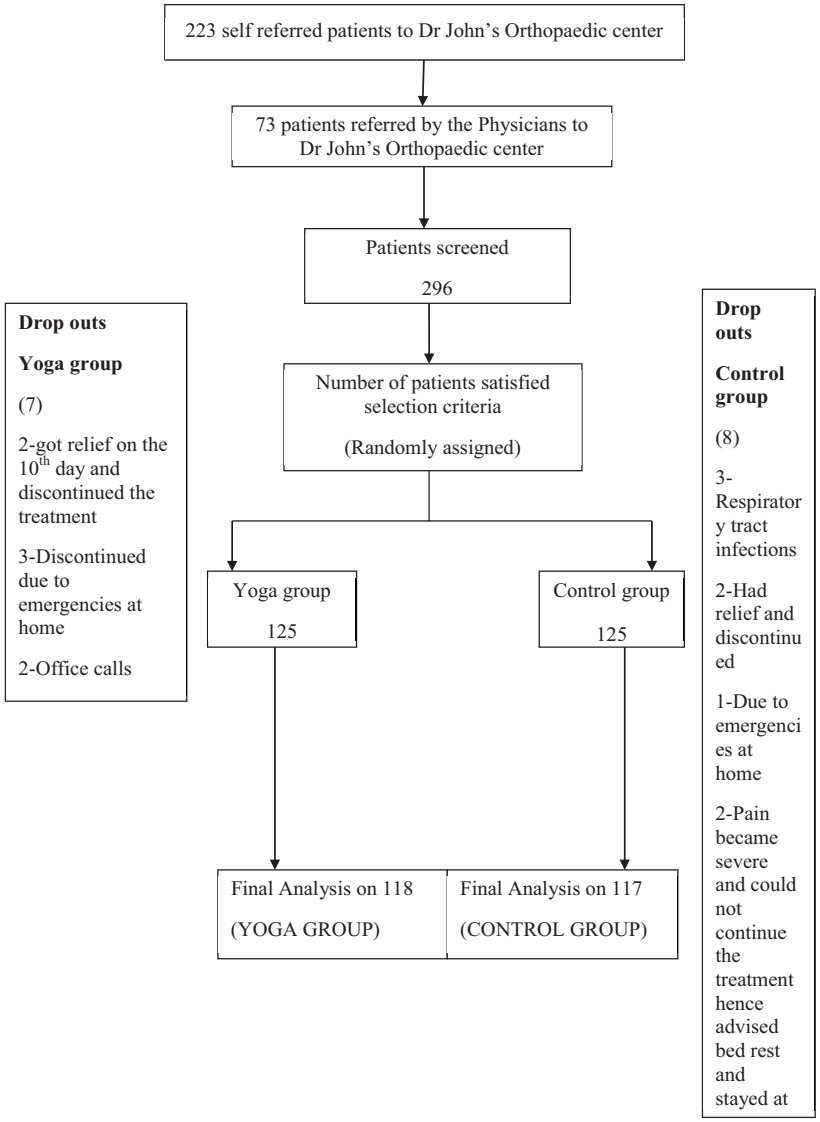

Figure 1: Trial profile of the study

Table 4: Results of variations of several parameters in SF-36 before and after integrated yoga therapy

Yoga group					
Variables	Pre and post	Mean ± SD	95% CI		*P* value
			LB	UB	
Physical functioning	Pre	12.03 ± 9.94	10.2215	13.8463	
	Po1	39.32 ± 11.24	37.2718	41.3722	<0.001
	Po2	67.50 ± 9.09	65.8410	69.1590	<0.001
Role limitation in physical health	Pre				
	Po1	52.33 ± 29.59	46.9347	57.7263	<0.001
	Po2	86.44 ± 16.55	83.4230	89.4584	<0.001
Emotional problems	Pre				
	Po1	56.17 ± 22.93	51.9892	60.3532	<0.001
	Po2	86.41 ± 17.59	83.2081	89.6224	<0.001
Energy/ fatigue	Pre	66.36 ± 5.66	65.3307	67.3981	
	Po1	50.10 ± 6.30	48.9560	51.2559	<0.001
	Po2	36.35 ± 6.08	35.2464	37.4654	<0.001
Emotional well-being	Pre	63.10 ± 7.17	61.7939	64.4095	
	Po1	48.88 ± 7.01	47.6017	50.1610	<0.001
	Po2	34.33 ± 5.46	33.3420	35.3359	<0.001
Social functioning	Pre	50.50 ± 6.82	49.2648	51.7522	
	Po1	57.83 ± 6.89	56.5820	59.0959	<0.001
	Po2	64.04 ± 8.92	62.4202	65.6731	<0.001
Pain	Pre	11.54 ± 11.55	9.4398	13.6534	
	Po1	47.88 ± 11.33	45.8139	49.9488	<0.001
	Po2	73.77 ± 12.67	71.4596	76.0828	<0.001
General health	Pre	36.91 ± 6.94	35.6459	38.1795	
	Po1	59.31 ± 12.24	57.0803	61.5451	<0.001
	Po2	77.47 ± 20.91	73.6644	81.2898	<0.001

Results within the yoga group; Po1 - Post (15th day); Po2 - (90th day); SD - Standard deviation; CI - Confidence interval; LB - Lower bound; UB - Upper bound; ES - Effect size

Table 5: Results of variations of several parameters in SF-36 before and after therapeutic exercises

Control group					
Variables	Pre and post	Mean ± SD	95% CI		*P* value
			LB	UB	
Physical functioning	Pre	12.82 ± 10.81	10.8401	14.8009	
	Po1	24.95 ± 13.93	22.4057	27.5089	<0.001
	Po2	50.94 ± 14.76	48.2361	53.6442	<0.001
Role limitation in physical health	Pre	0.21 ± 2.31	-0.2095	0.6369	
	Po1	35.47 ± 36.14	28.8516	42.0886	<0.001
	Po2	58.33 ± 44.52	50.1798	66.4868	<0.001
Emotional problems	Pre	0.56 ± 6.15	-0.5582	1.6967	
	Po1	31.02 ± 26.86	26.1063	35.9433	<0.001
	Po2	58.75 ± 38.94	51.6221	65.8839	<0.001
Energy/ fatigue	Pre	64.91 ± 5.41	63.9233	65.9057	
	Po1	58.97 ± 5.63	57.9434	60.0053	<0.001
	Po2	53.20 ± 6.86	51.9474	54.4629	<0.001
Emotional well-being	Pre	62.46 ± 6.61	61.2494	63.6737	
	Po1	57.43 ± 5.78	56.3760	58.4958	<0.001
	Po2	52.27 ± 5.91	51.1909	53.3562	<0.001
Social functioning	Pre	51.92 ± 9.37	50.2067	53.6395	
	Po1	52.67 ± 9.40	50.9489	54.3929	<0.001
	Po2	57.15 ± 10.42	55.2498	59.0664	<0.001
Pain	Pre	11.68 ± 9.11	10.0181	13.3580	
	Po1	30.21 ± 9.99	28.3831	32.0425	<0.001
	Po2	46.93 ± 11.22	44.8786	48.9881	<0.001
General health	Pre	36.99 ± 11.08	34.9652	39.0263	
	Po1	48.75 ± 9.26	47.0642	50.4555	<0.001
	Po2	60.12 ± 12.57	57.8180	62.4230	<0.001

Results within the control group; Po1 - Post (15th day); Po2 - (90th day); SD - Standard deviation; CI - Confidence interval; LB - Lower bound; UB - Upper bound; ES - Effect size

Role limitation in physical health

This measures problems with work or other daily activities as a result of physical health. The role limitation in physical health ($P < 0.001$) improved by increase of scores from 52.33 ± 29.59 to 86.44 ± 15.55 in the yoga group and 35.47 ± 36.14 to 58.33 ± 44.52 in the control group on the 15th and 90th days, respectively, with significantly better results in the yoga group than the control group ($P = 0.001$, Mann–Whitney U test).

Role limitation due to emotional health

This evaluates problems with work or other daily activities due to physical and emotional problems. The role limitation due to emotional health ($P < 0.001$) improved from 56.17 ± 22.93 to 86.41 ± 17.59 in the yoga group and from 31.02 ± 26.86 to 58.75 ± 38.94 in the control group on the 15th and 90th days, respectively, with significantly better results in the yoga group than the control group ($P = 0.001$, Mann–Whitney U test).

Energy and fatigue level

These levels are evaluated by finding out whether a person feels tired and worn out or feels full of pep and energy all the time. The energy and fatigue level improved in both groups ($P < 0.001$, Wilcoxon's) with reduction of scores from 66.36 ± 5.66 to 50.10 ± 6.30 and further to 36.35 ± 6.08 in the yoga group and from 64.91 ± 5.41 to 58.97 ± 5.6 and to 53.20 ± 6.8 in the control group on 15th and 90th days, respectively, with significantly better results in the yoga group than the control group ($P = 0.001$, Mann–Whitney U test).

Emotional well-being

This evaluates whether a person has problems or no problems with work or other daily activities as a result of emotional problems. In the yoga group, the emotional well-being ($P < 0.001$, Wilcoxon's) improved with reduction in scores from 63.10 ± 7.17 to 48.88 ± 7.01 and to 34.33 ± 5.46 and in the control group from 62.46 ± 6.61 to 57.43 ± 5.78 to 52.27 ± 5.91 on the 15th and 90th days, respectively, with significantly better results in the yoga group than the control group ($P = 0.001$, Mann–Whitney U test).

Social functioning

This evaluates whether the social activities are limited due to physical and emotional problems. In the yoga group,

Table 6: Results of SF-36 variables between groups (yoga and control groups)

Between groups			
Variables	Pre and post	ES	*P* value
Physical functioning	Pre		1.986
	Po1	1.13	<0.001
	Po2	1.35	<0.001
Role limitation in physical health	Pre		0.945
	Po1	0.51	<0.001
	Po2	0.84	<0.001
Emotional problems	Pre		0.945
	Po1	1.01	<0.001
	Po2	1.11	<0.001
Energy/fatigue	Pre		0.273
	Po1	1.48	<0.001
	Po2	2.60	<0.001
Emotional well-being	Pre		1.542
	Po1	1.33	<0.001
	Po2	3.15	<0.001
Social functioning	Pre		0.234
	Po1	0.63	<0.001
	Po2	0.71	<0.001
Pain	Pre		1.116
	Po1	1.65	<0.001
	Po2	2.24	<0.001
General health	Pre		1.239
	Po1	0.97	0.001
	Po2	1.01	0.001

Results between yoga and control groups; Po1 - Post (15th day); Po2 - (90th day); ES - Effect size

the emotional well-being ($P < 0.001$,Wilcoxon's) increased from 50.50 ± 6.82 to 57.83 ± 6.89 and to 64.04 ± 8.92 and in the control group from 51.92 ± 9.37 to (52.67 ± 9.40) and to 57.15 ± 10.42 on the 15th and 90th days, respectively, with significantly better results in the yoga group than the control group ($P = 0.001$, Mann–Whitney test).

Pain

This measures the severity of pain that limits the activities. Well-being on scores of pain improved in both groups ($P < 0.001$, Wilcoxon's) from 11.54 ± 11.55 to 47.88 ± 11.33 and to 73.77 ± 12.67 in the yoga group and in the control group from 11.68 ± 9.11 to 30.21 ± 9.09 and to 46.93 ± 11.22 on the 15th and 90th days, respectively, with significantly better results in the yoga group than the control group ($P = 0.001$, Mann–Whitney test).

General health

This evaluates the personal health of the individual. The general health increased in both groups ($P < 0.001$). It increased from 36.91 ± 6.94 to 59.31 ± 12.24 to 77.47 ± 20.91 in the yoga group from 36.99 ± 11.08 to 48.75 ± 9.26 to 60.12 ± 12.57 in the control group on the 15th and 90th days, respectively, with significantly better results in the yoga group than the control group ($P = 0.001$, Mann–Whitney U test).

DISCUSSION

This randomized two armed parallel control trial on 250 participants included patients of both genders ($F = 175$) in age 35–80 years with osteoarthritis of knees. Results showed significantly better improvement in the yoga group than the control group on all variables ($P < 0.001$, Mann–Whitney U test) of SF 36.

In a randomized controlled study on magnetic pulse treatment for knee osteoarthritis by Piptone *et al*. assessment of the patients at week 6 revealed a statistically significant improvement in pain and disability of the WOMAC questionnaire (Western Ontario and McMaster Universities) and EuroQol score (EuroQol or EQ-5D is a standardized measure of health status developed by the EuroQol group in order to provide a simple, generic measure of health for clinical and economic appraisal) in the active treatment group.[26]

Pain reduction

The reduction in pain observed in our study points to the beneficial effect of yoga as an add-on therapy to conventional physiotherapy practices.

In pilot studies on OA knees involving yoga, Kolasinski *et al*.,[27] Ranjita *et al*.[28] showed a better reduction of pain in the yoga group than the control group. In our study, we added yoga after the standard physiotherapy and 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 ha been observed by Garfinkel *et al*.[29] in a randomized controlled trial on yoga for carpal tunnel syndrome. Tekur *et al*.[15] studied the efficacy of the integrated approach of yoga therapy in patients with chronic low back pain and documented 48.8% reduction in Numerical Rating Scale scores in the yoga group. Garfinkel *et al*.[30] studied the effects of Iyengar yoga in patients with OA hands and found a better reduction in the pain during activity. Yogitha *et al*.[31] showed a reduction in pain and tenderness in patients with common neck pain after integrated yoga. In a study by Aglamiş *et al*.[11] there was a significant group differences in all domains of SF-36 ($P < 0.004$), while there were no group difference in WOMAC domains ($P > 0.004$). Baker *et al*.[32] found increases in the SF-36 physical function, physical role, social and mental health scores and physical performance scores and decreases in the WOMAC pain after a 4-month strength exercise program. Foley *et al*.[12] stated that after a 6-week exercise program physical performance increased,

the WOMAC score did not change, and the physical component of the SF-12 increased after hydrotherapy. Diracoglu *et al*.[13] observed increases in the SF-36 physical function, physical role, and vitality scores and the WOMAC physical function scores and physical performance in a kinesthetic group is greater than in a strength group after an 8 week exercise program. In a study by Kirkley *et al*. [14] in patients assigned to arthroscopic surgery there was no improvement with respect to physical function, pain, or health-related than those were assigned to the control group. In a study conducted at our center by Rangaji *et al*.[33] on the role of IAYT in the treatment of osteoporosis, he showed that in the comparison between the groups, the exercise group showed a significant difference in physical functioning component of SF-36 than the yoga group.

This study has revealed a statistically significant improvement in respect of all the domains of the SF 36 score with significantly better improvements in the yoga and control groups.

Mechanisms

Several factors would have contributed to the beneficial effects observed in both groups in this study. As noted in several earlier studies physiotherapy intervention may increase the blood glow. Better results in the yoga group could be due to its stress reducing effect since yoga is meant to bring about better emotional stability. Yoga is defined as 'samtvam yoga' in Bhagavadgita[34] which refers to 'the balanced state of mind under any demanding life situation, be physical or psychological (sheetaushnasukhaduhkheshusamah)'. This emotional stability is achieved by the multifactorial approach of yoga that includes safe physical practices (asanas), breathing techniques *(pranayama*), meditation (*dharana and dhyana*), and introspective corrections in one's cognitive errors by inputs at intellectual (*jnana yoga*) and emotional level (*bhakti yoga*).[35] This may have contributed to better health behavior and improved QOL.

Strengths of the study

Good sample size, randomized control design, active supervised intervention for the control group for the same duration as the experimental group and follow up for 3 months with good compliance (6% dropouts) are the strengths of this study. The result of this study that has shown marked differences between groups on all variables offers strong evidence for incorporating this module of IAYT for knees by the clinicians.

Suggestions for future work

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 light on the mechanisms.

CONCLUSIONS

Adjunctive program of the integrated approach of yoga therapy for OA knees improves all components of QOL on SF36. IAYT offers a good value addition as a nonpharmacological intervention in improving QOL in patients with OA knees.

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