

# Effectiveness of an Ayurvedic Treatment Protocol in Knee Ligament Injuries – An Observatory Report

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## SUMMARY

**Objective.** We aimed to document the effectiveness of an Ayurvedic treatment protocol in patients with knee ligament injuries.

**Methods.** We observed 20 patients with knee ligament injuries ranging from partial to complex meniscal/ligamentous pathological states who underwent an Ayurvedic treatment protocol. Knee Outcome survey (KOOS) and International Knee Documentation Committee (IKDC) scores were assessed as baseline figures along with supportive radiological reports if available such as an MRI and the same scores were used to assess the effectiveness of the Ayurvedic treatment protocol. Person centered stage wise administration of Ayurvedic medicaments and external therapies were carried out for the concerned patients. The outcome measures of change in KOOS and IKDC scores were analyzed pre-treatment [a1], post-treatment [a2] and after a follow-up [a3] of 3 months. Data analysis was carried out using Statistical Package for Social Sciences (SPSS). The ordinal data was subjected to Friedman's test. Post Hoc comparisons were carried out using Wilcoxon test (with Bonferroni correction). Results with p-value < 0.01 were considered significant.

**Results.** There were statistically significant differences in KOOS and IKDC scores between a1 and a2; & a1 & a3. When analyzed between a2 & a3 in the prescribed parameters, results were statistically insignificant. KOOS-Overall scores with Friedman's test between a1, a2 and a3 were  $\chi^2(2) = 28.737, p = 0.000 < 0.01$ . Post hoc analysis with Wilcoxon signed-rank tests (at Bonferroni-adjusted significance level) between a1 & a2 gave results  $Z = -3.921, p = 0.000 < 0.017$  and between a1 & a3 it was  $Z = -3.771, p = 0.000 < 0.017$ . Between a2 & a3 the result was  $Z = 0.000, p = 1.000 > 0.017$ . IKDC score with Friedman's test between a1, a2 & a3 were  $\chi^2(2) = 32.430, p = 0.000 < 0.01$ . Post hoc analysis with Wilcoxon signed-rank tests, between a1 & a2 was  $Z = -3.920, p = 0.000 < 0.017$  and between a1 & a3 was  $Z = -3.922, p = 0.000 < 0.017$ . The analysis between a2 & a3 gave result  $Z = -2.234, p = 0.025 > 0.017$ . A variable in knee joint rehabilitation viz. the body mass index (BMI) of the patients did not seem to influence the results. The treatment was found to be comparatively more effective in females and in patients who engaged in moderate labour as well as who led a sedentary lifestyle. Elderly population though of less number in the study, experienced improved joint stability and relief in symptoms statistically as well as clinically.

**Conclusions.** The preliminary analysis of this observatory report indicates that suggested Ayurvedic treatment protocol is effective in knee ligament injuries, wherein it improves joint stability, reduces the symptoms of pain, swelling, stiffness and rehabilitates the individual towards his daily activities of strenuous/non strenuous origin. The effectiveness observed after the treatment phase sustained across the follow up period of 3 months as well. To substantiate the effectiveness of the prescribed Ayurvedic treatment protocol in decelerating the osteoarthritis onset in a traumatic knee injury requires long term follow-ups. Yet we have documented some positive leads from this report wherein Ayurvedic treatments may be adopted for effective and non-invasive rehabilitation of knee ligament injuries ranging from partial to complex origin and also in decelerating the risk of developing early osteoarthritis.

## KEY WORDS

*Ayurvedic management; knee ligament injury; rehabilitation.*

## BACKGROUND

The knee, a compound synovial joint is the largest weight bearing joint which plays a significant role while adopting major routine postures and activities as a part of daily living such as sitting, walking and running. Thus, an injury to the knee adversely affects the quality of life of an individual irrespective of his/her age, gender and occupation. The function and stability of the knee in fact depends on specific muscles, ligaments, cartilage, synovial and other connective tissues (1). The most common knee injury observed in clinical practice is Anterior Cruciate Ligament (ACL) tear which is about 86.5%, followed by Lateral & Medial meniscal injuries which are around 78.24% (2). At times multi ligamentous knee injuries comprising of a wide range of ligaments and intra articular injury patterns are also reported in orthopedic clinics. There are operative methods aiming at anatomical reconstruction and non-operative treatment strategies for rehabilitation and recovery to the pre-injury status and at delaying the post traumatic osteoarthritis onset (3).

A manuscript on multi ligamentous knee injuries, concluded that, the effectiveness of treatments adopted in knee injuries remained controversial due to lack of prospective comparative clinical outcome studies and patient reported outcome. It also suggested the need of individualized rehabilitation protocols towards expected outcomes (4). A literature review on conservative or surgical treatments in anterior cruciate ligament tears observed that, the concept of reduced chances of further meniscal lesions in a surgically reconstructed ACL may not be just because of the intervention but may also result from a decrease in strenuous activities post-surgery (5). It is estimated that 60.2% of sport person does not return to strenuous activities after an anatomical reconstruction of their injured knee (2). The aforementioned literature review concluded that there was not enough evidence to recommend a reconstruction surgery more than a systematic neuromuscular rehabilitation in ligament injuries of knee. Also, whatever be the treatment modality the chances of post traumatic osteoarthritis could also not be denied. Quadriceps weakness, flexion contractures and patella femoral pain etc. post a knee injury hamper the activities of daily living to a significant extent even after adopting surgical correction or neuromuscular rehabilitation (5).

Susruta Samhita, an Ayurvedic treatise details various surgical, parasurgical and other manipulative techniques intended to restore and rehabilitate injured joints and other connective tissues (6). An overview of various forms of bandages and immobilizing techniques is found in this textbook. Current Ayurvedic clinical practices in such joint

pathologies has evolved from these conventional methods and have been upgraded to patient centered quality care intending restoration to the activities of daily living.

We report an Inpatient level observation of 20 patients admitted at National Ayurveda Research Institute for Panchakarma, Cheruthuruthy, Kerala; diagnosed with injuries to the ligaments of knee following which who underwent Ayurvedic treatment protocol. In concerned patients with Ayurvedic treatments that comprised of internal administration of specific medicaments and external therapies we noted significant improvement in the parameters of pain, swelling and functional disability of the knee joint. Patients were able to return to activities of daily living with improved joint stability. This suggests the applicability of Ayurvedic healthcare approaches in joint injuries of sports or non-sports origin. Although Ayurvedic physicians exhibit clinical expertise in rehabilitating acute or subacute traumatic joint disorders, neuromuscular and connective tissue pathologies; minimal effectiveness studies are published in this arena. Ayurvedic therapies also hold substantial scope in the field of Sports Medicine. This observation intends to report the effectiveness of Ayurvedic treatment strategies in ligament injuries of knee.

## METHODS

This is an observational report of 20 cases admitted in NARIP, Cheruthuruthy between the time period May to September 2019 diagnosed with knee ligament injuries ranging from partial to complex ones and who underwent Ayurvedic treatment protocol. Information on the knee injury was recorded based on the patient history and supportive radiological report. Personal information such as age, weight, height, and occupation were recorded. Knee Outcome Survey (KOOS) (7) and International Knee Documentation Committee (IKDC)- subjective evaluation score 8 were used to determine the extent of insult with regards to activities of daily living and involvement in sports and recreational activities. Person centered stage wise administration of Ayurvedic medicaments and external therapies were carried out for the concerned patients (**table I**).

The outcome measures of change in the KOOS and IKDC scores were analyzed pre-treatment [a1], post-treatment [a2] and after a follow-up [a3] of 3 months. Data analysis was carried out using Statistical Package for Social Sciences (SPSS). The ordinal data was subjected to Friedman's test. Post Hoc comparisons were carried out using Wilcoxon test (with Bonferroni correction). Results with p-value < 0.01 were considered significant.

**Table I.** Person centered stage wise management of the symptoms in knee ligament injury.

Sl No.	Stage	Internal Medicine*	External therapy*	Approximate duration of the treatment
01	Acute/Inflammatory phase (Vrana shopha stage)	1. Rasnasaptaka kashaya 2. Yogaraja Guggulu	1. Dasamoola Kashaya Dhara <sup>1</sup> 2. Lepana <sup>2</sup> with Nagaradi choornam 3. Bandana <sup>3</sup> with Murivenna oil	3 – 7 days/ until swelling subside (If swelling is not present, directly stage 2 can be initiated)
02	Post Inflammatory phase (Vrana stage/ Bhagna stage/ Vatahara stage)	1. Dhanvantaram Kashaya 2. Gandha thylam	1. LT bandana 2. Abhyanga <sup>4</sup> with Dhanvantaram oil 3. Janu (Knee) Dhara <sup>1</sup> with Dhanvantaram oil 4. Matra Basti <sup>5</sup> with Dhanvantaram Mezhupakam oil	7 days
03	Final stage (Vatahara/ Bhruhmana stage)	1. Dhanvantaram Kashaya 2. Gandha thylam	1. Annalepanam <sup>6</sup> 2. LT bandana	7 days
04	Follow up stage (rehabilitative phase)	1. Dhanvantaram Kashaya 2. Gandha thylam	1. LT bandana 2. Quadriceps exercises 3. Diet rich in calcium, Vit.D, Zinc and magnesium	LT bandana is to be done daily for 1month, every alternative days for 2 months, weekly twice for next two months and weekly once in the last month. No.2 & 3 is advised for 6 months

\*Details of medicines are attached as supplementary material as Supplementary file with the manuscript

<sup>1</sup>Controlled & systematic pouring of herbal decoctions and medicated oils, <sup>2</sup>external application of paste, <sup>3</sup>bandaging, <sup>4</sup>massage technique, <sup>5</sup>enema with medicated oil, <sup>6</sup>external application of medicated rice.

Selected internal medicines (**table I**) and medicines for external therapies were procured from a GMP certified company.

The external therapies namely Abhyanga (massage technique), Lepana-Annalepana (external applications, **figures 11, 12, 13** & ... \Photos & Videos\Video Rec.2 (Annalepanam).mp4), Kashaya dhara – Taila dhara (controlled & systematic pouring of herbal decoctions and medicated oils **figures 8, 9** & ... \Photos & Videos\Video Rec.1 (Janu dhara).mp4), Matra Basti (enema with medicated oils) and Bandhana (bandaging techniques, **figure 10**) were administered in the Panchakarma theatres of the Institute.

## OBSERVATIONS

### Demography

Out of 20 patients observed, females and males represented about 45 % and 55 % respectively of the total sample. While considering the nature of work that the concerned patients adopted as a part of daily living; 20% of the patients were

indulged in heavy labour (building workers and the like), 55% of the patients executed moderate labour (such as a home maker) and the remaining 25% had sedentary lifestyles (indulging in long hours of desk work).

Other characteristics considered were variables such as age, height, weight and body mass index (BMI) for which the mean, standard deviation, range and Confidence intervals were analyzed (**table II**).

### Type and extent of knee ligament insult

Based on type of ligaments injured; 14 patients were recorded with meniscal tear and the remaining 06 patients presented with cruciate ligament injury (**table III**).

### Effectiveness of the Ayurvedic treatment protocol – KOOS and IKDC scores

The effectiveness of the Ayurvedic treatment protocol were assessed in terms of percentage increase in KOOS and IKDC scores recorded post treatment (after treatment and after the follow up period of 3 months, **table IV**)



**Figure 11.** Method of preparation of Medicated njavara rice paste:

'Njavara or shastika-sali' (*Oryza Sativa L.*) is a traditional medicinal rice grown in Southern part of India which is extensively used in Ayurvedic treatments. The rice is cooked in a decoction prepared with milk and a herb namely bala (*Sidare-tusaLinn*) and applied over the affected area.



**Figure 12.** Medicated Njavara rice paste.



**Figure 13.** Massaging both the knee joints with medicated njavara rice paste. Refer to video recording no.2.



**Figure 8.** Materials required for Janudhara with medicated oil.



**Figure 9.** Procedure of Janudhara – with medicated oils, Refer to video recording no.1.



**Figure 10.** Bandaging technique.



**Table II.** General Characteristics of the sample.

Sample variables	MeanSD	Range	95% CI
Age	38.6512.96	52	(32.97,44.33)
Height	152.26.89	25	(149.18,155.22)
Weight	63.659.09	35	(59.67,67.63)
BMI	27.574.16	18.6	(25.75,29.39)

**Table III.** Extent of knee ligament insult.

Type of injury	Complete	Percentage	Partial	Percentage	Total
Medial meniscal / Lateral meniscal tear	03	23	10	77	13
Posterior cruciate ligament / Lateral cruciate ligament tear	03	43	04	57	07

**Table IV.** Summary of Scores.

Score	Pre-treatment Median Score (IQR)	Post-treatment Median Score (IQR)	Follow-Up Median Score (IQR)
KOOS-Pain	49.50(42.00-68.00)	81.00(71.40-91.25)	80.00(76.25-91.25)
KOOS-Symptom	55.50(46.00-69.25)	91.00(71.00-96.00)	93.00(79.00-99.00)
KOOS-ADL	57.50(44.50-96.25)	87.50(69.75-96.25)	86.50(81.25-96.00)
KOOS Sport/ Rec	32.50(11.25-48.75)	72.50(51.25-78.75)	72.50(51.25-85.00)
KOOS-QOL	31.00(19.00-44.00)	63.00(40.25-78.00)	59.50(44.00-83.25)
Overall KOOS Score	49.50 (42.00-68.00)	81.00(71.50-91.25)	80.00(76.25-91.25)
IKDC Score	34.45(26.13-42.80)	70.70(53.73-77.00)	75.85(62.63-88.80)

### KOOS score

The outcome measures of change in KOOS Score were analyzed using the prescribed sub parameters namely pain, other symptoms, ADL, sport/rec, quality of life and overall KOOS Score. The scores were measured pre-treatment (a1), post-treatment (a2) and after a follow-up of 3 months (a3) - (**figures 1,2,3,4,5,6**). For each of the study variable, it was observed that the KOOS score differed significantly with respect to pre and post treatment phases, whereas no significant change was observed between the post-treatment and follow-up scores. These results suggested that the scores improved significantly after the treatment phase and the improved scores were maintained at follow-up period of three months.

Friedman's test was conducted on a sample of size  $n = 20$  for each of the study variables (**table V**). There was a statistically significant difference in scores measured during the three periods for pain, symptoms, ADL, sports/rec, QoL and overall score.

Further, results of the Post hoc analysis using Wilcoxon signed-rank tests at Bonferroni-adjusted significance level ( $p < 0.017$ ) for the sub parameters between a1 & a2 phase assessments and a1 & a3 showed significant difference at 1% level. However no significant difference was observed in the scores measured during phase a2 & a3 (**table VI**).

These results showed that the scores improved significantly after the treatment phase and were consistent even after a follow-up period of three months. The effect sizes for each of these variables suggested a moderate to high clinical significance.

### IKDC scores

As for KOOS, a Friedman's test was conducted to compare the IKDC scores measured at a1 phase, a2 & at a3 (**tables V, figure 7**). There was a statistically significant difference in scores measured during the three periods with  $\chi^2(2) = 32.430$ ,  $p = 0.000 < 0.01$ . Post hoc analysis with Wilcoxon

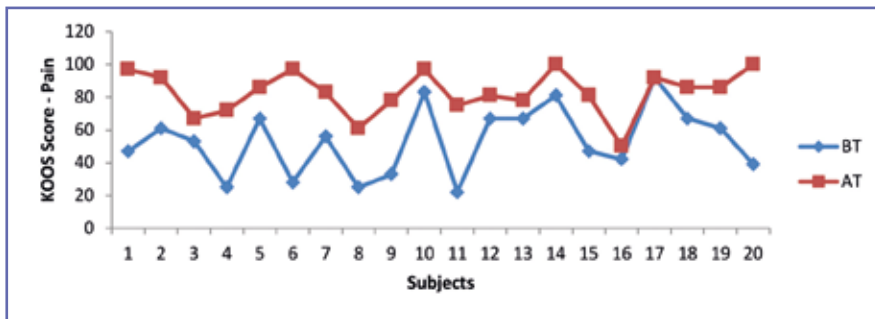


Figure 1. KOOS pre-treatment and post-treatment scores for pain.

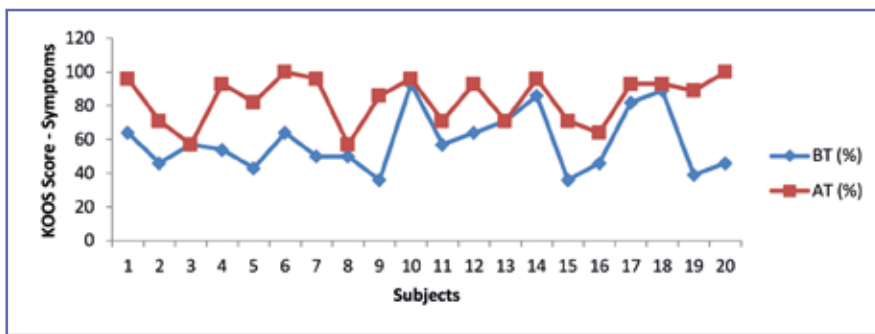


Figure 2. KOOS pre-treatment and post-treatment scores for other symptoms.

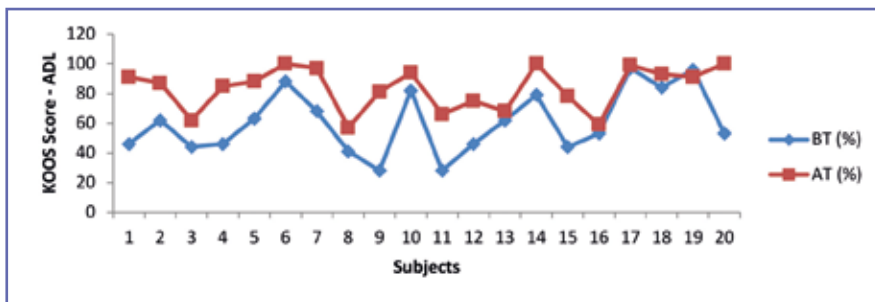


Figure 3. KOOS pre-treatment and post-treatment scores for ADL.

Table V. Friedman’s test results on KOOS parameters and IKDC scores after treatment (n=20).

Score	Chi square Value	P-value
KOOS-Pain	26.083	<0.01*
KOOS-Symptom	27.634	<0.01*
KOOS-ADL	17.636	<0.01*
KOOS Sport/ Rec	26.587	<0.01*
KOOS-QOL	19.541	<0.01*
Overall KOOS Score	28.737	<0.01*
IKDC Score	32.430	<0.01*

\*Results significant at 1% level

signed-rank tests at Bonferroni-adjusted significance level (0.017) revealed that IKDC scores for symptoms that measured changes between a1 & a2 scores showed significant results with  $Z = -3.920$ ,  $p = 0.000 < 0.017$ , with effect size  $r = -0.619$  and between a1 & a3 with  $Z = -3.922$ ,  $p = 0.000 < 0.017$ ; with effect size  $r = -0.620$ . As in KOOS the effect sizes, for each variable suggested a moderate to high clinical significance. No significant difference was observed in the scores measured a2 & a3 with  $Z = -2.234$ ,  $p = 0.025 > 0.017$ . Like KOOS observations, these results too suggested that the scores improved significantly after the treatment and the improved scores were consistent after a follow-up period of three months (table VI).

Some patients reported at the OPD after a period of 6 months (8/20) to 1 year (9/20). In those selected patients, Wilcoxon test was conducted to determine whether there was a significant difference in the KOOS–IKDC scores observed after such long-term follow-ups (tables 11, 12). The results indicated that scores recorded after treatment showed no significant difference even after a follow-up period of 6 months to 1 year.

### Effectiveness of the treatment protocol with respect to sample variables

Age, gender, nature of work and BMI were assessed with respect to KOOS and IKDC scores (tables VII, VIII, IX). Here, the percentage increase in IKDC and KOOS score after the treatment were more evident in elderly people than others. But, as the number of elderly patients was less (05%) compared to the other age groups, this may not be generalized. While considering the gender wise distribution and the effectiveness of the treatment, percentage increase in mean KOOS and IKDC scores were more evident in females.

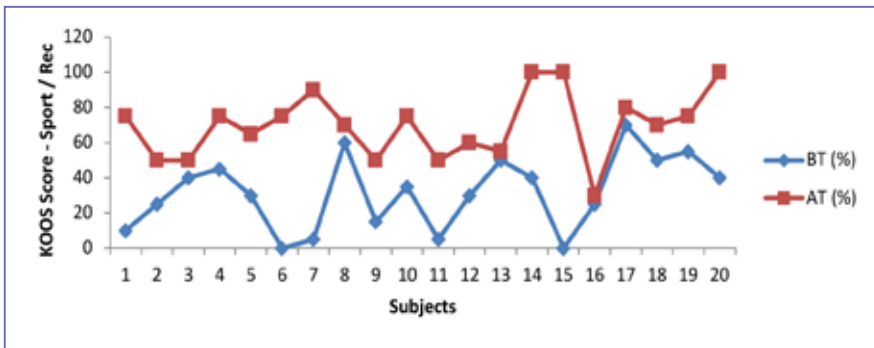


Figure 4. KOOS pre-treatment and post treatment scores for sports/rec.

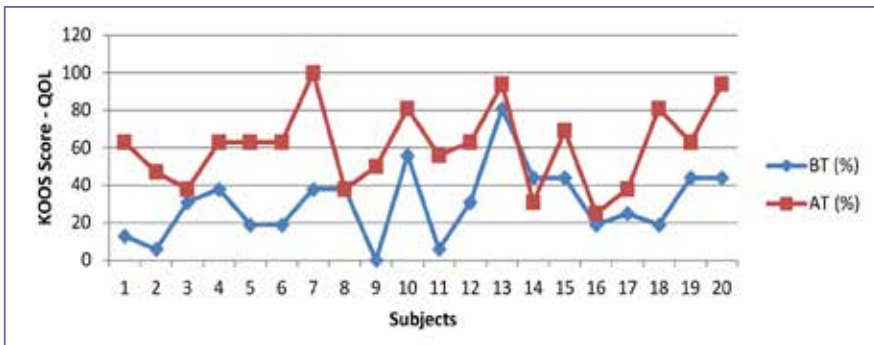


Figure 5. KOOS pre-treatment and post treatment scores for QoL.

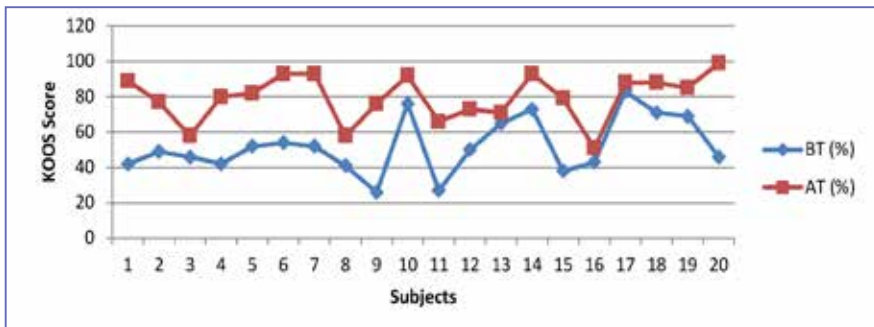


Figure 6. KOOS pre-treatment and post-treatment over all scores.

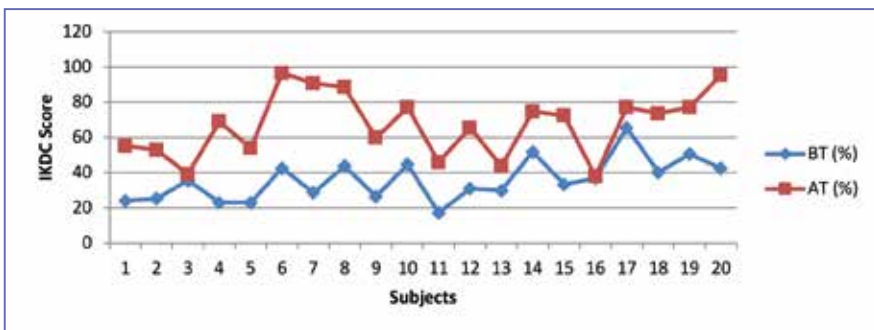


Figure 7. IKDC pre-treatment and post treatment scores.

Further, patients who indulged in moderate labour showed a better response to the treatment protocol in terms of improvement scores on an average, with respect to IKDC, whereas those who lead sedentary lifestyles responded more as far as KOOS scores were considered

While considering the type of ligament injury and the effectiveness of the treatment adopted, it was found that in patients with complete meniscal tear, there was a significant increase in KOOS scores after adopting the treatment protocol. In case of IKDC score, significant improvement in mean percentage score was evident in patients with partial meniscal tear (table X)

Considering the variable body mass index (BMI) and effectiveness of the treatment adopted, measured using KOOS and IKDC scores, there was no significant correlation (Spearman's correlation co-efficient (KOOS)-rho = 0.036, p value = 0.880 > 0.01 and (IKDC) rho = - 0.032, p value = 0.894 > 0.01 ) between BMI and the improvement in scores.

## DISCUSSION

### Janu sandhi marma (the knee joint)

Ayurveda is an established complementary healthcare service that originated in India. Because of its person centered diagnostic methods and personalized treatment modalities, it is gaining global attention from various health related communities. WHO is significantly contributing towards upgrading the traditional practices in Ayurvedic Sciences to Evidence Based Medicine considering the increase in demand of Ayurvedic herbals among the global patient community (9). Susruta Samhita is an ancient textbook that was written as early as about 1000 BC, most of which was dedi-

**Table VI.** Post hoc analysis using Wilcoxon signed-rank tests at Bonferroni-adjusted significance level ( $p < 0.017$ ) for the KOOS sub parameters and IKDC scores.

Score	Phase a1 – a2		Phase a1 – a3		Phase a2 – a3	
	Z Value	P-value & Effect size	Z Value	P-value & Effect size	Z Value	P-value
KOOS-Pain	-3.826	<0.01*; -0.605	-3.463	<0.01*; -0.548	-1.197	>0.01
KOOS-Symptom	-3.724	<0.01; -0.588	-3.812	<0.01*; -0.603	-0.385	>0.01
KOOS-ADL	-3.847	<0.01* -0.608	-3.398	<0.01*; -0.537	-0.071	>0.01
KOOS Sport/ Rec	-3.923	<0.01*; -0.620	-3.717	<0.01*; -0.587	-0.057	>0.01
KOOS-QOL	-3.699	<0.01*; -0.585	-3.219	<0.01*; -0.509	-0.341	>0.01
Overall KOOS Score	-3.921	<0.01*; -0.619	-3.771	<0.01*; -0.596	0.00	>0.01
IKDC Score	-3.920	<0.01*; -0.619	-3.922	<0.01* -0.620	-2.234	>0.01

\*Results significant at 1% level

**Table VII.** Age wise distribution and percentage changes in IKDC and KOOS scores.

Age group	Frequency (in %)	% Increase in Score	
		IKDC	KOOS
Young	20	26.5	33.93
Adults	75	26.8	29.91
Elderly	5	38	46

**Table VIII.** Gender wise distribution and percentage changes in IKDC and KOOS scores.

Gender	Frequency (in %)	% Increase in Score	
		IKDC	KOOS
Female	45	35.22	35.53
Male	55	20.81	28.23

**Table IX.** Amount of labour/strenuous activities and percentage changes in IKDC and KOOS scores.

Amount of labour/ strenuous activities	Frequency (in %)	% increase in IKDC Score	% increase in KOOS score
Heavy Labour	20	19	29.33
Moderate Labour	55	32.45	31.9
Sedentary / Desk Job	25	23.4	35.88

**Table X.** Mean percentage score improvement and extent of knee ligament insult.

Mean percentage score improvement	MM / LM Tear		ACL tear	
	Complete	Partial	Complete	Partial
KOOS	38.67	28	22.33	17.25
IKDC	32.60	34.73	24.93	26.47

cated to surgical and parasurgical manipulations. Kshara sutra (medicated seton), kshara karma (caustic alkali), agni karma (cautery), rakta moksha (blood-letting), plastic reconstruction of facial characters with special mention to

ear, nose and lip, manipulations in bhagna (fractures) and sandhimoksha (joint dislocations) such as aanchana (traction), peedana (compression), samkshepa (immobilization) and bandhana (bandaging) have been explained in this



**Table XI.** Wilcoxon values –KOOS & IKDC post-treatment and at follow-up of 6 month in selected patients.

Score	Comparison of scores measured After treatment and at Follow-up	
	Z Value	P-value
KOOS-Pain	-2.038	0.042>0.01
KOOS-Symptom	-0.524	0.600>0.01
KOOS-ADL	-1.193	0.233>0.01
KOOS Sport/ Rec	-1.355	0.176>0.01
KOOS-QOL	-0.350	0.726>0.01
Overall KOOS Score	-1.183	0.237>0.01
IKDC Score	-1.684	0.092>0.01

textbook. Different types of surgical instruments, suturing materials, usage of twine for ligature, different types of bandaging techniques, dressing materials, splints for fractured bones too are mentioned. Bandaging techniques were specific to the severity of the condition, seasonal variations and the anatomical sites (10) (Sootrasthana 16/ 86-89).

Marmas (vital points) were considered as the conjuncture site of multiple anatomical structures as asthi (bone), sandhi (joints), peshi (muscles) sira (blood vessels) and snayu (ligaments, tendons or anatomical suture lines). There are five different types of marmas of which one is sandhi marma (Joints) (10) (Sharirasthana 6/369-370).

Janu sandhi or the knee joint is considered as a sandhi marma, which when traumatized (janumarma abhighata) results in khanjatva (disability/ weakness) (10) (Sharirasthana 6/372-373). Based on the prognosis of the knee insult, the knee is considered as a vaikalyakara marma. Vaikalyakara marmas are those vital points in the human body which when traumatized results in permanent disability. The specialty of vaikalyakara marma such as the knee joint is that a timely and an appropriate intervention from a good physician shall restore the activities of the tissue afflicted at this site (10) (Sharirasthana 6/370).

### Expected effectiveness of procedures

The treatment procedure of “dhara” represents the rhythmic and systematic pouring of medicaments over specific body parts or the entire body surface for a stipulated time. In case of knee ligament injuries, two specific dhara procedures are adopted; the kashaya dhara (pouring of herbal decoctions) and the taila dhara (pouring of medicated oils) (figures 8, 9). Kashaya dhara is selected in an inflammatory phase and taila dhara is appropriate where inflam-

**Table XII.** Wilcoxon values – KOOS and IKDC post-treatment and at follow-up of 1 year in selected patients.

Score	Comparison of scores measured After treatment and at Follow-up – 1year	
	Z Value	P-value
KOOS-Pain	-0.105	0.917>0.01
KOOS-Symptom	-0.845	0.398>0.01
KOOS-ADL	-0.593	0.553>0.01
KOOS Sport/ Rec	-1.119	0.263>0.01
KOOS-QOL	-1.183	0.237>0.01
Overall KOOS Score	0.508	0.611>0.01
IKDC Score	-1.125	0.260>0.01

matory signs are minimal, i.e., in a degenerative phase. The medicines selected for herbal decoction in Kashaya dhara is Dasamoola (roots of ten different herbs). Dasamoolakashaya is effective in reducing swelling and other signs of inflammation (11) (Guduchyadivarga, 49). An animal study conducted by Parekar et al has proven the analgesic and anti-inflammatory potential of Dasamoola (12). Taila dhara is done with Dhanvantaram oil which is specifically indicated in traumatic injuries is expected to strengthen the musculoskeletal framework (13) (Sharirasthana, 2/47-52).

“Lepana” refers to local application of medicated pastes. Application of paste or the lepa is the first and foremost treatment for inflammation (10) (Sutrasthana, 18/3). Nagaradi choornam (the herbal combination of powdered drugs) along with tamarind leaf juice was used here as lepa. The ingredients in Nagaradi choorna (Suppl. file) possess anti-inflammatory and analgesic properties<sup>14</sup> (ChurnaKalpana). After mixing the medicated powder with the prescribed leaf juice, the mixture is heated and when warm, is applied over the afflicted joint. Tamarind juice possesses anti-inflammatory, analgesic and antinociceptive effects (15) and thus is expected to enhance the therapeutic effects of the herbal drugs.

“Abhyanga” refers to specific massaging techniques with medicated oils. After the acute/inflammatory phase, abhyanga is specifically indicated in fractures and other joint pathologies (16) (Sutrasthana, 3/54-55). Here, abhyanga was done with Dhanwantaram oil (18) (Suppl. file).

Matra-basti is the trans-rectal administration of medicaments especially medicated oils, in predetermined doses. It is expected to reduce the symptoms of pain and stiffness and it also strengthens musculoskeletal systems. Dhanwantaram Mezhukupaka (Mezhukupaka is a special preparation with medicated oils exclusively prepared for transrectal administration) was selected here for the matra basti procedure.

Bandhana refers to unique bandaging techniques that immobilizes the joint and thereby promotes the healing process (10) (Sootrasthana 16-17). Susrutha Samhita has given prime importance to the bandaging techniques in the treatment of injuries. He has given detailed description of various types of bandage materials and fourteen types of bandaging techniques (10) (Sutrasthana, 18/86-89). Here in the management of ligament injuries, bandaging was done initially i.e., in the inflammatory phase with Murivenna oil (Suppl. file). Murivenna is medicated oil which is used for healing contusions, wounds and fractures. The medicines used in the preparation of Murivenna possess anti-inflammatory properties (17).

In the post inflammatory phase, bandaging was done with specific herbal combination named as LT bandhana (**figure 10**); (suppl. file). LT bandhana possess anti-inflammatory, analgesic, antioxidant, tissue regeneration and joint strengthening properties (14, 18, 19). Coconut meat scrap and egg white used in this bandage is rich in protein, trace minerals (Mg, Zn) and vitamins which help in wound healing, tissue building, collagen formation, reduction of inflammation and strengthen the bone, muscles and tendons (20, 21). On bandaging the joint with medicines mixed with egg white and coconut meat scrap, in addition to immobilizing the joint; enough nutrition is also being supplied transdermally which may accelerate the tissue regeneration and strengthen ligaments, muscles, tendons and thereby it improves the joint stability.

Annalepa refers to application of a paste prepared out of cooked 'njavara' medicinal rice variety, over specific body parts. This is a method administered to nourish the joint, enhance joint stability and delay the onset of post traumatic osteoarthritis (**figures 11,12,13**).

The medicinal properties of njavara may be attributed to its anti-oxidant<sup>22</sup> and anti-inflammatory activities<sup>23</sup>. High thiamine and Ph, K, Na, Ca, Mg contents in the njavara rice indicates the reason why it is found clinically effective in degenerative joint pathologies, muscular atrophies and neuritis.

### **Ayurvedic intervention and observed results in knee ligament injuries**

Ayurvedic interventions show clinically significant improvements in traumatic/degenerative joint pathologies with special mention in delaying osteoarthritis onset. The approach is usually patient centered with individualized treatment guidelines and medicaments. This observatory report is a primary analysis based on patient reported outcomes after Ayurvedic treatments in knee ligament injuries.

Do Kyung Kim (24) discussed regarding the compromised extensor muscle strength and reduced improvement in

females compared to males after reconstruction surgery, making them difficult to rehabilitate (24). But in this report, after the treatment phase and while the follow up period, improved knee indices in form of improved KOOS and IKDC scores were found in female patients compared to male counterparts. This is a positive lead.

While assessing the KOOS-IKDC scores, the treatment protocol gave statistically significant results after the treatment phase and the improved scores were consistent even after the follow up period. Clinically also the patients reported improved joint stability and reduction in symptoms such as pain, swelling and joint stiffness.

Ayurvedic treatment was more significant in improving KOOS and IKDC scores in meniscal injuries than cruciate ligament tears. Interestingly, in patients with partial meniscal injuries, changes in IKDC scores were more significant than KOOS scores. Conversely, in complete meniscal injuries changes in KOOS scores were rather more significant. Also, while considering the amount of labour that the patients engaged in as a part of daily living, those who indulged in moderate labour as homemakers got higher IKDC scores than KOOS scores after treatment. Conversely, those who led a sedentary lifestyle responded to the treatment with improved KOOS scores than IKDC scores. A probable reason for these observations may be the fact that KOOS scores are more concerned with scoring the total disability index with respect to symptoms of meniscal and ligament injuries like pain, swelling and stiffness than functional and stability status. IKDC subjective evaluation score emphasizes functional status with respect to activities of daily living/ indulge in strenuous activities. As patients with meniscal injuries responded more when compared to patients with cruciate ligament tears, it is inferred that Ayurvedic treatments improves the functional status of the joint by reducing the symptoms rather than imparting the functional stability.

Richard F Loesser (25) stated that elderly population were more vulnerable to traumatic knee injuries and if manifested were difficult to rehabilitate due to co morbidities such as sarcopenia and osteopenia<sup>25</sup>. But in this study, elderly participants reported significant relief in symptoms with improved joint stability after the treatment protocol. The statistical significance reported in this sample is not generalizable as the number of elderly patients was less compared to the other age groups, yet this seems a positive lead in rehabilitating knee injuries with Ayurvedic interventions in elderly.

While considering a significant variable namely the BMI which is related to rehabilitation of the knee injuries (26), knee being an important weight bearing joint; this report found no correlation between BMI of the patients and the

extent of improvement in KOOS and IKDC scores. This is a crucial finding where the results were equally significant in all participants irrespective of their BMI.

### Limitations and recommendations

This observatory report lacks radiological evidence after the treatment phase or follow up. A significant confounder namely, the nature of trauma (acute traumatic/ chronic degenerative) with respect to time of initiation of the treatment protocol in patients was not taken into account as these factors were not adequately represented in the sample. But out of curiosity a Mann Whitney U test on improvement in KOOS and IKDC scores across the acute traumatic and chronic degenerative groups yielded insignificant results (KOOS- U= 34, p-value > 0.01; IKDC- U= 35.5, p-value > 0.01) which meant the treatment was effective irrespective of the nature of trauma and time of initiation of treatment. But as afore mentioned, this cannot be generalized due to insufficient representation of this cofounder in the studied sample. Also, long term follow ups are very crucial in knee ligament injuries to collect data on incidence of osteoarthritis, indulgence in strenuous activities, functional indices with respect to activities of daily living etc. Some patients reported to the OPD as a part of long-term follow ups (6 months to 1 year), and the results indicated that the statistical significance noted after treatment sustained even after such long-term follow ups. This is a definite positive lead in knee rehabilitation. Yet it seems incorrect to generalize these finding as all patients did not turn up after such long-term follow ups. This study thus lacks such long term follow up data. Samples

with equal representation of all possible risk factors would help produce a stronger evidence for the findings.

There are effective Ayurvedic treatment strategies and rehabilitation techniques to treat acute, subacute and chronic knee ligament injuries which are of partial or complete origin. This observation gives a primary insight on specific non-invasive Ayurvedic treatments which are commonly practiced in knee ligament injuries that give promising results in knee joint rehabilitation by reducing symptoms of pain, swelling and stiffness and thereby restoration to the activities of daily living. Even such treatments may be adopted following a reconstruction surgery where knee joint stiffness and other symptoms prevail after surgery. Randomized clinical trials may be conducted to compare the efficacies of such person centered alternative medical approaches with standard treatments like reconstruction surgeries. Also, there is significant scope of integrative approaches in effective recovery where Ayurvedic treatment protocols may be added to standard reconstruction surgeries/ non-invasive rehabilitation techniques in injuries of sports or non-sports origin. Appropriate implementation, evaluation and interpretation of clinical findings are fundamental and crucial in case reporting (27). This report shall stand as a significant background to appropriately designed, implemented, evaluated and interpreted clinical trials of different traditional and alternative medical practices in musculo-skeletal disorders/ injuries of varied origin.

### CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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