

Effect of Tele - Yoga As An Adjunctive Therapy on Pain, Quality of Life, Perceived Stress and Functional Capacity in Patient with Degenerative Disc of Lumbar Spine: A Case Report

Shreedevi Badigera¹, Bindu S², Shivaprasad Shetty³, Prashanth Shetty⁴,
Moodala Girishankara K S⁵

^{1,3,5}Department of Yoga Therapeutics, S.D.M College of Naturopathy and Yogic Sciences, Ujire, Karnataka, India.

²Department of Natural Therapeutics, S.D.M College of Naturopathy and Yogic Sciences, Ujire, Karnataka, India.

⁴Department of Nutrition and Dietetics, S.D.M College of Naturopathy and Yogic Sciences, Ujire, Karnataka, India.

Abstract:

This case report explores the efficacy of a therapeutic yoga protocol in alleviating pain, perceived stress, enhancing quality of life (QoL) and functional capacity in a 40-year-old female patient diagnosed with degenerative disc disease (DDD) of the lumbar spine. Following a 10-day inpatient yoga program at a residential center, the patient was monitored through regular follow-ups over 36 weeks. Clinical assessments included the Dallas Pain Questionnaire, Short Form-36 Health Questionnaire, Functional Rating Index, and Perceived Stress Scale. Despite minimal changes observed in MRI findings, significant subjective improvements were reported across all assessed parameters, including improvement in Dallas pain subscales like Daily Activities (42% - 39%), Work/Leisure (50% - 25%), Anxiety / Depression (70% - 15%) and Social Activities (60% - 15%), enhanced functional capacity (75% - 15%), reduction in Perceived stress scale (PSS) (23 - 13) and also improvement seen in SF 36 Health Questionnaires Subscales, Physical function (25% - 60%), Role limitation due to physical health (0% - 75%), Role limitation due to emotional problems (0% - 100%), Energy / fatigue (30% - 90%), emotional well-being (48% - 92%), social functioning (37.5 % - 75%), Pain (22.5% - 90%), General Health (50% - 75%). The integrated approach of yoga, combining physical postures, breathing exercises, and meditation, contributed to these outcomes. This study is the first to document the impact of a therapeutic yoga protocol on lumbar spine DDD using a Tele-yoga format, highlighting the potential of non-pharmacological interventions in managing chronic pain and improving overall well-being. Future research with larger randomized controlled trials is warranted to further validate these findings and generalize the therapeutic benefits of yoga in clinical practice.

Key words: Case Report, Disc degenerative disease (DDD), Functional Capacity, Pain, Quality of life, Yoga

1. Introduction:

The spine is the main supporting structure of the human body. It protects spinal cord and gives flexibility and support to it (1). Degenerative intervertebral disc disease (DDD) is one common contributing factor for back pain (2,3). It is said that in evolutionary development, the lumbar spine has more vulnerable to get degenerative disease. It affects both genders, with the incidence usually around 40 years and also which increases with age (2). Every year, 266 million people are diagnosed with disc degeneration of the lumbar spine worldwide (4). The etiology of DDD has been associated with multiple factors like physical loading, vehicular driving, spinal trauma, smoking, obesity, genetic influences, etc.(5). Disc degenerative disease (DDD) damages the structural integrity, the formation of disc herniation, osteophytes, and vertebral micro fracture, which impairs the intervertebral disc's ability to withstand physiological loads (3). More than 90% of herniated discs occur at the L4-L5 or L5-S1 disc spaces, where they press on the L4, L5, or S1 nerve roots. This compression causes radiculopathy in the posterior leg and the dorsal foot (5,6). The diagnosis of DDD is made by Clinical findings and Magnetic resonance imaging (MRI). Many patients will get improvement without having surgical intervention. Physical therapy should be tried for at least six weeks, with a focus on core strengthening and stretching (5).

Non-pharmacological intervention like yoga, which is a mind-body intervention. Yoga is a safe, effective, low-cost and less side effect(7). Yoga is having an effect on reducing chronic pain. Previous studies have shown that, yoga has a proven benefit on alleviating chronic neck pain (10–12) and lower back pain (10,13,14). Previous RCT has shown that yoga was found to decrease kyphosis in senior women and men with adult onset hyper kyphosis (15) and also a another study has shown that practice of Classic Iyenger plank pose has significantly reduced the angle of primary scoliotic curves in Idiopathic and Degenerative Scoliosis (16). Yoga also helps reducing perceived stress (17), anxiety, and depression (18,19) and improves quality of life and spinal mobility in chronic lower back pain patients(20). Previous study which has shown that long-term practice of yoga helps in reducing the age related disc degeneration (21). Hence we planned to conduct a single case report with the aim of long term practice of therapeutic yoga protocol has reducing pain, perceived stress, improves QoL and ROM in disc degeneration of Lumbar spine.

2. Presenting Complaints:

Mrs. PTM, a 40-year-old female, had been diagnosed with degenerative disc changes in the lower lumbar region in 2021. She underwent physiotherapy for two months at a local physiotherapy clinic in Bangalore. On August 22, 2023, she was admitted to a residential yoga center in South India for a 10-day program with complaints of lower back pain radiating to both legs, more prominently to the left. The pain was aggravated by prolonged sitting and forward bending. She also experienced difficulty getting up from a seated position and rising from bed, which had persisted for two years. Pain relief was achieved with hot applications to the back and mild to moderate extension exercises.

3. Clinical Findings:

The subject's height was 153 cm, and her weight was 52 kg, resulting in a BMI of 22.5 kg/m². Vital sign

were as follows: blood pressure 122/84 mm Hg, pulse rate 74 bpm, and respiratory rate 16 cpm. The Straight Leg Raise (SLR) test was positive between 45 and 55 degrees, indicating nerve root irritation. The Crossed Straight Leg Raise test was negative. However, the Slump Test showed positive results, suggesting neural tension or lumbar nerve root irritation.

4. Diagnostic Focus and Assessments:

We Measured the Severity of pain using Dallas Pain Questionnaire. The Short Form-36 Health Questionnaire was used to assess the quality of life. To measure the level of pain and degree of disability Functional rating index (FRI) was used. To assess the stress of a patient Perceived stress scale was used. MRI was used to diagnose the disease. All the assessments were carried out at the baseline, during 10th day and follow up was for 12 weeks and 36 weeks. The first MRI was done on 6/11/2021 and during the admission the First MRI was used as a diagnostic tool and Second MRI was done on 14/5/2024.

5. Methods:

The therapeutic Yoga protocol was developed by the Licensed Naturopathy and Yoga Physician after complete case taking and obtained written consent from the patient. The patient was counseled regarding the treatment protocol, yogic management and its benefit.

6. Therapeutic Intervention: Therapeutic Yoga practice

After complete detailed case taking, the yoga protocol was planned. During the first day of admission complete details of the study, mode of intervention, duration of the study, rules and regulation of the yoga practice and what precautions should be taken during the practice was explained. First 10 days the yoga was taken through offline one to one session under the guidance of Professional Yoga Doctor, after 10 days, the yoga was taken via online weekly 6 days for the period of 10 months. The therapeutic yoga protocol is given in **table 1**.

Table 1: Yoga for Degenerative disc if Lumbar spine

	Day	Practices	Duration
Preliminary step:	Every day	3 rounds of Aum with Salutation to maharishi patanjali	2 minutes
Kriya:	Every day	Kapalabhati (1 stroke per second, not forcefully)	2 minutes
Loosening Exercises:	Every day	Neck exercises, Shoulder, Elbow, wrist and ankle joints	10 minutes
Breathing Excises:	Monday	Hand in and out breathing, Hand stretch breathing, Single leg raising breathing, Setubandasana breathing, Supta Udarakarshanasana breathing, Bhujangasana breathing, Shalabasana breathing	10 minutes
Standing series of asanas:	Tuesday and Thursday	Tadasana, Ardha Kati Chakrasana	4 minutes
	Wednesday and Friday	Kati Chakrasana, Ardha Chakrasana	
Supine series of asanas:	Tuesday and Thursday	eka pada padottanasana, Setu bandasana,	

	Wednesday and Friday	Supta Kapotasana, Supta Udarakarshanasana	4 minutes
Prone series of asanas:	Tuesday to Friday	Sarala Bhujangasana, Shalabhasana	4 minutes
Sitting series of asanas:	Tuesday and Thursday	marijari asana, Vajrasana	4 minutes
	Wednesday and Friday	Ardha Ustrasana, Balasana	
Pranayamas:	Monday, Tuesday and Thursday	Sectional breathing, Nadishodana Pranayama, Surya bhedana pranayama	10 minutes
	Wednesday and Friday	Sectional breathing, Seetali/Sitkari/Sadanta, Bhramari	
Meditation Techniques:	Saturday	Mind Sound Resonance Technique/ Cyclic Meditation/ Pranic Energization Technique, AUM meditation	25 – 30 minutes (Alternate week)
Relaxation Techniques:	Everyday night	Yoga nidra	30 minutes
	Every day	Quick Relaxation technique Deep Relaxation technique	5 minutes 10 minutes

7. Follow-up

Patient came for regular follow up visit and followed a regular yoga regimen which was advised by the Yoga Doctor. The patient came for follow-up visit, which was scheduled for the first time on 12th week and Second Visit on after 40 weeks. On every visit patient was expressed her present complaints and improvements were recorded. Complaints and Improvements were recorded in patients own words. The timeline of the study presented in **Figure. 1**. No other interventions were given other than Therapeutic Yoga Protocol. As per recent follow up her pain, Anxiety, stress has been reduced and improvement in Range of Movement and QoL was observed and patient was happy with her improvement and maintaining well.

Timeline:

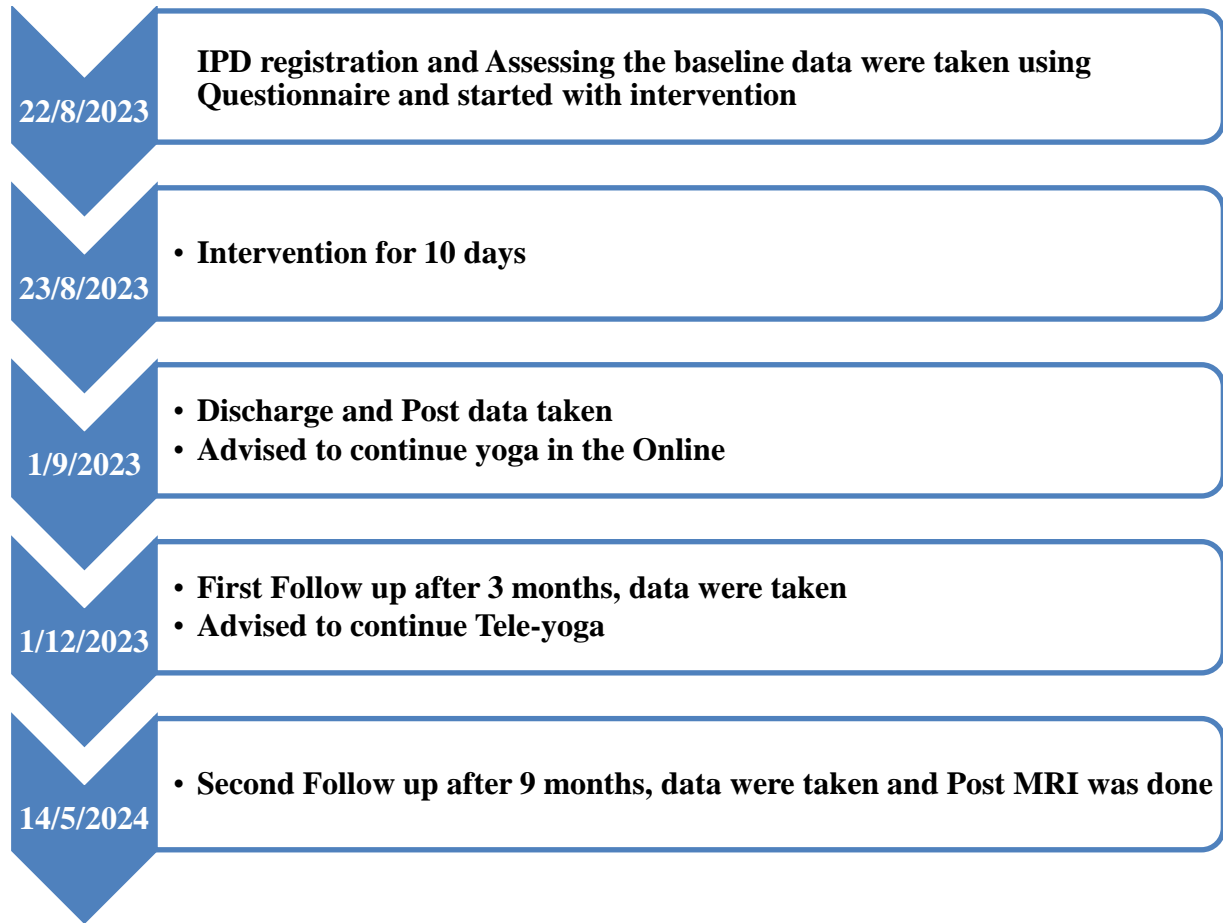


Figure 1. A detailed study of patient about the treatment and follow up

8. Outcomes:

The results indicated that there was no significant improvement observed in the second MRI spine compared to the first MRI, as shown in Fig. 4. However, notable progress was observed in subjective variables. The Dallas Pain Questionnaire and its subscales demonstrated reductions in pain-related impacts, including Daily Activities (42% to 39%), Work/Leisure (50% to 25%), Anxiety/Depression (70% to 15%), and Social Activities (60% to 15%). Additionally, the Functional Rating Index improved significantly (75% to 15%), and the Perceived Stress Scale (PSS) score decreased from 23 to 13. Improvements were also seen in the SF-36 Health Questionnaire subscales: Physical Function (25% to 60%), Role Limitation Due to Physical Health (0% to 75%), Role Limitation Due to Emotional Problems (0% to 100%), Energy/Fatigue (30% to 90%), Emotional Well-being (48% to 92%), Social Functioning (37.5% to 75%), Pain (22.5% to 90%), and General Health (50% to 75%).

At the end of nine months of intervention, sustainable improvements were evident in the patient’s pain scale, Functional Rating Index, Perceived Stress Scale, and SF-36 Quality of Life (QoL) scores. The patient reported reduced radiating pain in the legs and the ability to perform regular daily activities with less pain and fatigue. Additionally, there was a significant reduction in anxiety and stress, alongside improvements in quality of life, overall well-being, and functional health status.

Table 2: Changes in Dallas pain Questionnaire (DPQ) from Baseline to 9 months follow-up

Categories	Score			
	Baseline	10 th day	First follow - up (3 months)	Second follow-up (9 months)
Daily activities	42%	36%	69 %	39%
Work/Leisure	50%	35%	35%	25%
Anxiety / Depression	70%	35%	30%	15%
Social Activities	60%	35%	15%	15%

Table 3: Changes in Functional Rating Index (FRI) from Baseline to 9 months follow-up

	Score			
	Baseline	10 th day	First follow - up (3 months)	Second follow-up (9 months)
FSI	75%	62.5%	32.5%	15%

Table 4: Changes in Perceived Stress Scale (PSS) from Baseline to 9 months follow-up

	Baseline	10 th day	First follow - up (3 months)	Second follow-up (9 months)
PSS (Total score)	23	-	13	13

Table 5: Changes in SF 36 Questionnaires from Baseline to 9 months follow-up

Scale	Score			
	Baseline	10 th day	First follow - up (3 months)	Second follow-up (9 months)
Physical functioning	25%	-	60%	60%
Role limitation due to physical health	0%	-	50%	75%
Role limitation due to emotional problems	0%	-	66.67%	100%
Energy/fatigue	30%	-	70%	90%
Emotional well-being	48%	-	80%	92%
Social functioning	37.5%	-	87.5%	75%

Pain	22.5%	-	45%	90%
General Health	50%	-	65%	75%

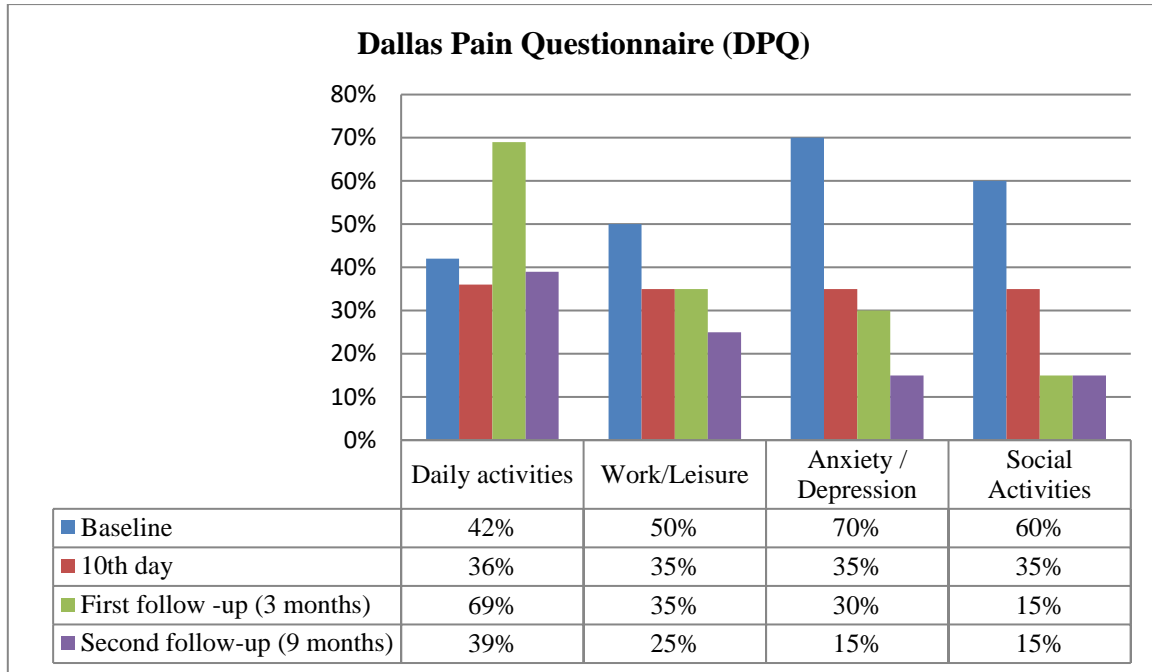


Figure 2: Changes in Dallas Pain Questionnaire (DPQ)

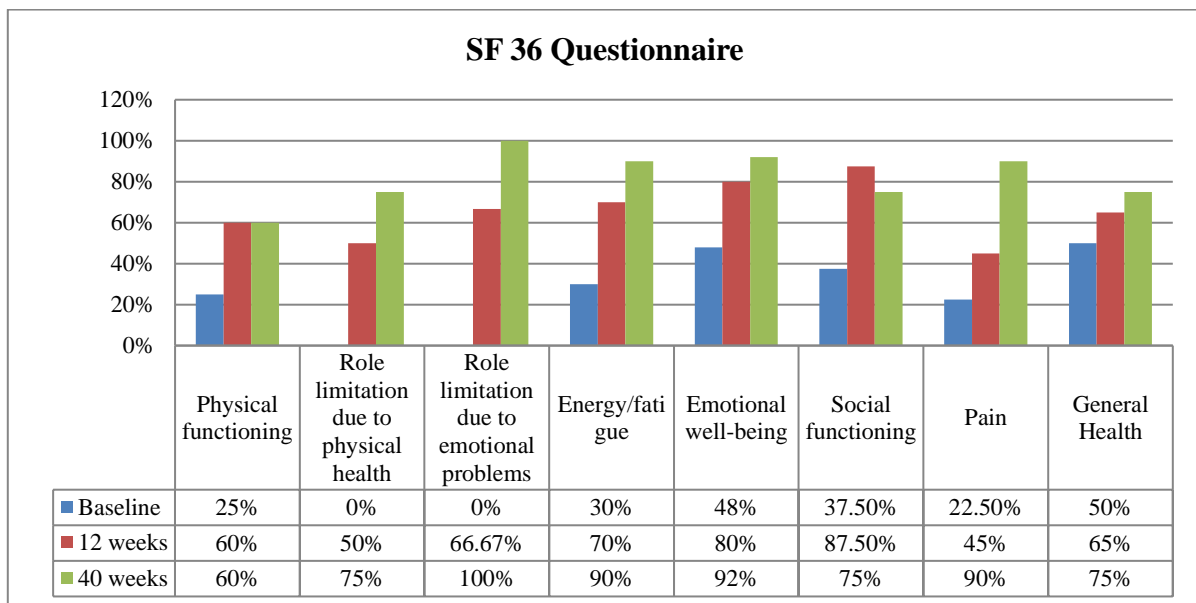


Figure 3: Changes in SF 36 Health Quality of life questionnaire

**Figure 4: Baseline and Post Changes seen in MRI of LS Spine
Baseline MRI on 6/11/2022**



HEGDE DIAGNOSTIC CENTRE
 MRI, SPIRAL C.T. SCAN, DIGITAL X-RAY,
 COLOUR DOPPLER, ULTRASOUND & HIGH TECH LAB

KIRAN C.G HOSPITAL ROAD, P.J. EXTENSION, DAVANGERE - 577 004
 78926 78856, 08192-270553 Mob: 94480 53652 www.hegdediagnosticcentre.com

NAME: Prathima hegde	AGE: 39/F
REF Dr. DR veerendraswamy S H	DATE: 6.11.2021

MRI LUMBO-SACRAL SPINE

Multiplanar MR imaging of lumbo-sacral spine was performed with T1, T2 & STIR sequences on appropriate topograms.
 Lumbar spine curvature-normal
 Modik type II end plate changes noted in L4,L5 vertebral bodies.
 Facet joint arthritis noted from L3-L4 to L5-S1 level.
 End plate changes noted from L4 to S1 level.
 Lumbar discs appears dehydrated from L4-L5 to L5-S1 level.
 L4-L5 -asymmetric disc bulge noted,with bilateral grade I neural foramina narrowing. mild spinal canal narrowing noted Spinal canal APD -13mm. no nerve root indentation noted.
 Asymmetric disc bulge noted at L5-S1 level causing spinal canal narrowing APD -11mm with grade III neural foramina narrowing noted bilateral nerve root(exiting) compression noted annular tear noted.
 Rest of lumbar discs appear normal.
 The prevertebral and paravertebral soft tissue are normal in appearance.
 Mild Spondylotic changes noted in cervical spine ,no significant spinal canal or neural foramina narrowing noted.

IMPRESSION:
 Degenerative disc changes noted in lower lumbar levels maximum at L5-S1 level causing spinal canal narrowing and nerve root compression bilaterally.
 Annular tear noted posteriorly at L5-S1 level.

DR RINESH K MD
 RADIOLOGIST

Consultant Radiologists :
Dr. S.R. HEGDE, M.B.B.S., D.M.R.E., M.D., (Rad.)

Dr. KIRANKUMAR HEGDE S.
 M.B.B.S., M.D., (RADIO-DIAGNOSIS)

Post MRI on 14/05/2024



DEPARTMENT OF RADIO DIAGNOSIS & IMAGING
VICTORIA HOSPITAL, BANGALORE-560002

NAME:	PRATHIMA DINESHA HEGADE	AGE/SEX:	42Y/F	DATE:	14.05.2024
OP/IP No.:	VHRD904332	UNIT:		MRI NO.:	

MRI OF THE LUMBAR SPINE WITH WHOLE SPINE SCREENING PROTOCOL: T1, T2- SAG, AXIAL, T2 TIRM COR & SAG- LUMBAR T2 SAG- CERVICAL AND THORACIC SCREENING

Clinical indication: C/o low back ache since 4 years

FINDINGS:

- Exaggerated lumbar lordosis noted.
- Vertebral bodies are normal in height.
- Spinal cord is normal in thickness and signal intensity and ends at level of body of L1 vertebra
- Bilateral Sacro-iliac joints appear normal.
- T1 hypointense and T2/STIR hyperintense lesion noted in the L1 vertebral body-? Atypical lipid poor intraosseous hemangioma.
- T2 hyperintense lesion noted in the T12 vertebral body-? Hemangioma
- Conus medullaris is normal.

Intervertebral Disc:

L1-L2 and L2-L3:
No disc desiccation.
No e/o disc bulge.
No e/o neural foramen /spinal canal stenosis noted.

L3-L4:
Diffuse symmetrical disc bulge causing indentation of anterior thecal sac. However no e/o spinal canal stenosis, bilateral neural foraminal narrowing / nerve root impingement

L4-L5:
Diffuse asymmetrical disc bulge causing indentation of anterior thecal sac and bilateral neural foraminal narrowing. However no e/o spinal canal stenosis / nerve root impingement.

L5-S1:
Diffuse asymmetrical disc bulge causing indentation of anterior thecal sac. Posterior annular tear noted. However no e/o spinal canal stenosis/ bilateral neural foraminal narrowing/ nerve root impingement. Left facet joint arthropathy noted.

WHOLE-SPINE SCREENING:

FINDINGS:

- Vertebral bodies are normal in height.
- Articular facets and facet joints are normal.
- Cervical spinal cord is normal in thickness and signal intensity
- C-V junction normal.

Intervertebral discs:

Disc-osteophyte complex noted at level C4-C5, C5-C6 and C6-C7 causing indentation of anterior epidural sac.

OTHERS:
Multiple T1 and T2 hypointense lesions noted in anterior and posterior walls of uterus largest measuring ~3.0x2.8cm in anterior wall – S/o Fibroids (Suggested USG correlation)

IMPRESSION:

- Disc desiccation , left facet arthropathy, posterior annular tear and diffuse asymmetrical disc bulge at level L5- S1 causing indentation of anterior thecal sac and bilateral neural foraminal narrowing.
- Diffuse symmetrical disc bulge at level L3-L4 and L4-L5 causing indentation of anterior thecal sac.

Dr. **AYUSH K. MURTHY**
Jr. (M.D., M.Ch.)
DEPT. OF RADIO-DIAGNOSIS
(PG-2019)

Dr. **NHARUKA**
SENIOR RESIDENT
DEPT. OF RADIO-DIAGNOSIS
BMCCH

Dr. **ARJUN PRAKASH**
ASSOCIATE PROFESSOR
DEPT. OF RADIO-DIAGNOSIS
BMCCH

Dr. **VIJAY KUMAR K R**
PROFESSOR AND HOD
DEPT. OF RADIO-DIAGNOSIS
BMCCH

9. Discussion:

A 40-year-old woman with lumbar spine DDD has participated in a 10-day Therapeutic yoga program. At the 36th week of follow-up, all the subjective measures showed a significant improvement, while the LS spine MRI showed no change following discharge. The patient expressed interest in the holistic, non-pharmacological intervention and found the therapeutic yoga module to be easy and comfortable to use,

which further improved her condition. According to the authors, the improvement seen in the patient is due to regular practice of therapeutic yoga protocol with regular follow-up.

According to the Adhija Vyadhi Model, all diseases originate in the mind as a result of stress, which affects breathing and the physical body. The integrated approach to yoga, which includes physical postures, breathing, and meditation, aids in the management of psychological stress, ultimately leading to physical benefits (22,23). Our therapeutic yoga module also contains an integrated yogic approach, which includes loosening exercises, breathing exercises, physical postures, and meditations, which helped our patient, recover from her condition.

Magnetic resonance imaging revealed that the group of long-term yoga practitioners had much less degenerative disc disease than a matched control group in a previous matched case-control study regarding yoga and disc degenerative disease in the cervical and lumbar spine (21). Previous Randomized Controlled trials performed by others, have shown that practice of Yoga helps in reducing chronic back (13,17,18,24) and neck pain (8,12,25,26), reduces stress(20), anxiety (18,20,25), depression (18,20), improves sleep(27,28), Quality of life (QoL) (12) and Improves ROM (18,20).

The significant improvement we found in the subjective variables was due to the integrated approach of yoga and good compliance from the patient. In 10 days of the inpatient yoga program, the patient got little improvement, and in the follow-up phase, the tele-yoga program contributed to sustainable improvement in all the subjective variables with patient adherence to the yoga protocol during the follow-up period. The therapeutic yoga protocol which was made by the Yoga doctor were validated from previous researches and administered on patient. The team of Yoga physicians was learnt about the integrated approach of Yoga in Disc degeneration of spine.

As per authors knowledge this is first ever study which was done on therapeutic yoga protocol on Disc degeneration of lumbar spine using Tele-yoga. The strength of the study is has we used integrated approach of yoga we found positive health effect of therapeutic yoga on health outcomes in DD of LS. To generalize this protocol in clinical practice the large robust randomized controlled trails are needed.

10. Conclusion:

The case report has shown improvement in pain and functional rating index at 10 days of inpatient yoga program in patient with degenerative disc of lumbar spine. The sustainable improvement was seen during the 36 weeks of follow-up in pain, functional rating index, QoL, and reduction in perceived stress. This protocol seems to be safe and easy to treat in patients with DD of LS.

11. Patient Perspective:

I was suffering from back pain from 2021; first I underwent physiotherapy in 2021, and pain has reduced for 2 months and again recurs. After an MRI report, they have been diagnosed as disc degeneration of the lumbar spine. The back pain was radiating to my legs, and I was not able to get up from a sitting position or climb stairs. After I was admitted to the Yoga holistic center, I underwent therapeutic yoga protocol for 10 days as an inpatient and 9 months of online yoga. Now my pain has reduced tremendously, I can get up from a sitting position, I can climb stairs, and my stress and anxiety have reduced. I can do my housekeeping work, my sleep also improved, and my gait also improved compared to before.

12. Informed Consent:

Before initiating the study, comprehensive verbal and written information about the research was provided to the patient. This included details about the purpose, procedures, potential risks, benefits, and duration of the study. The patient was encouraged to ask questions at any time for clarification and was assured that their queries would be addressed thoroughly. The patient was informed that participation was entirely voluntary and that she could withdraw her consent at any time during the study without the need to provide a reason, and this would not affect her ongoing or future medical care. Signed informed consent was obtained after ensuring that the patient fully understood the study details. Additionally, specific consent was obtained for the publication of anonymized clinical details and reports, ensuring the patient were aware of and comfortable with how her information would be used in research dissemination.

References:

1. Parenteau CS, Lau EC, Campbell IC, Courtney A. Prevalence of spine degeneration diagnosis by type, age, gender, and obesity using Medicare data. *Sci Rep.* 2021 Mar 8;11(1):5389.
2. Scarcia L, Pileggi M, Camilli A, Romi A, Bartolo A, Giubolini F, et al. Degenerative disc disease of the spine: from anatomy to pathophysiology and radiological appearance, with morphological and functional considerations. *J Pers Med.* 2022; 12(11):1810.
3. Hemanta D, Jiang X xing, Feng Z zhou, Chen Z xian, Cao Y wu. Etiology for degenerative disc disease. *Chin Med Sci J.* 2016;31(3):185–91.
4. Ravindra VM, Senglaub SS, Rattani A, Dewan MC, Härtl R, Bisson E, et al. Degenerative Lumbar Spine Disease: Estimating Global Incidence and Worldwide Volume. *Glob Spine J.* 2018 Dec;8(8):784–94.
5. Donnally III CJ, Hanna A, Varacallo M. Lumbar Degenerative Disk Disease. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024.
6. Mostofi K, Moghaddam BG, Khouzan RK, Daryabin M. The reliability of LERI's sign in L4 and L3 radiculalgia. *J Clin Neurosci.* 2018; 50:102–4.
7. Lu YH, Rosner B, Chang G, Fishman LM. Twelve-minute daily yoga regimen reverses osteoporotic bone loss. *Top Geriatr Rehabil.* 2016;32(2):81–7.
8. Schmid AA, Fruhauf CA, Sharp JL, Van Puymbroeck M, Bair MJ, Portz JD. Yoga for People With Chronic Pain in a Community-Based Setting: A Feasibility and Pilot RCT. *J Evid-Based Integr Med.* 2019 Aug 8;24:2515690X19863763.
9. Seguin-Fowler R, Graham M, Ward J, Eldridge G, Sriram U, Fine D. Feasibility of a yoga intervention to decrease pain in older women: a randomized controlled pilot study. *BMC Geriatr.* 2020;20.
10. Groessl EJ, Casteel D, McKinnon S, McCarthy A, Schmalzl L, Chang DG, et al. Comparing Types of Yoga for Chronic Low Back and Neck Pain in Military Personnel: A Feasibility Randomized Controlled Trial. *Glob Adv Health Med.* 2022; 11.
11. Li Y, Li S, Jiang J, Yuan S. Effects of yoga on patients with chronic nonspecific neck pain. *Medicine (Baltimore).* 2019 Feb 22;98(8):e14649.
12. Michalsen A, Trautteur H, Lüdtkke R, Brunnhuber S, Meier L, Jeitler M, et al. Yoga for chronic neck pain: a pilot randomized controlled clinical trial. *J Pain.* 2012;13(11):1122–30.

13. Sherman KJ, Cherkin DC, Erro J, Miglioretti DL, Deyo RA. Comparing Yoga, Exercise, and a Self-Care Book for Chronic Low Back Pain: A Randomized, Controlled Trial. *Ann Intern Med.* 2005 Dec 20;143(12):849.
14. Williams KA, Petronis J, Smith D, Goodrich D, Wu J, Ravi N, et al. Effect of Iyengar yoga therapy for chronic low back pain. *Pain.* 2005;115(1–2):107–17.
15. Greendale GA, Huang MH, Karlamangla AS, Seeger L, Crawford S. Yoga decreases kyphosis in senior women and men with adult-onset hyperkyphosis: results of a randomized controlled trial. *J Am Geriatr Soc.* 2009;57(9):1569–79.
16. Fishman LM, Groessl EJ, Sherman KJ. Serial Case Reporting Yoga for Idiopathic and Degenerative Scoliosis. *Glob Adv Health Med.* 2014 Sep;3(5):16–21.
17. Berlowitz J, Hall DL, Joyce C, Fredman L, Sherman KJ, Saper RB, et al. Changes in Perceived Stress After Yoga, Physical Therapy, and Education Interventions for Chronic Low Back Pain: A Secondary Analysis of a Randomized Controlled Trial. *Pain Med Off J Am Acad Pain Med.* 2020 Jun 4;21(10):2529–37.
18. Tekur P, Nagarathna R, Chametcha S, Hankey A, Nagendra HR. A comprehensive yoga programs improves pain, anxiety and depression in chronic low back pain patients more than exercise: an RCT. *Complement Ther Med.* 2012;20(3):107–18.
19. Joyce C, Roseen EJ, Keysor JJ, Gross KD, Culpepper L, Saper RB. Can Yoga or Physical Therapy for Chronic Low Back Pain Improve Depression and Anxiety Among Adults from a Racially Diverse, Low-Income Community? A Secondary Analysis of a Randomized Controlled Trial. *Arch Phys Med Rehabil.* 2021 Jun;102(6):1049–58.
20. Singphow C, Purohit S, Tekur P, Bista S, Panigrahy SN, Raghuram N, et al. Effect of Yoga on Stress, Anxiety, Depression, and Spinal Mobility in Computer Users with Chronic Low Back Pain. *Int J Yoga.* 2022;15(2):114–21.
21. Jeng CM, Cheng TC, Kung CH, Hsu HC. Yoga and disc degenerative disease in cervical and lumbar spine: an MR imaging-based case control study. *Eur Spine J.* 2011 Mar;20(3):408–13.
22. Nagendra HR. Yoga its basis and applications. Swami Vivekananda Yoga Prakashana; 2010.
23. Gowda S, Mohanty S, Saoji A, Nagarathna R. Integrated Yoga and Naturopathy module in management of Metabolic Syndrome: A case report. *J Ayurveda Integr Med.* 2017;8(1):45–8.
24. Tilbrook HE, Cox H, Hewitt CE, Kang'ombe AR, Chuang LH, Jayakody S, et al. Yoga for chronic low back pain: a randomized trial. *Ann Intern Med.* 2011 Nov 1;155(9):569–78.
25. Yogitha B, Nagarathna R, John E, Nagendra H. Complimentary effect of yogic sound resonance relaxation technique in patients with common neck pain. *Int J Yoga.* 2010;3(1):18–25.
26. Nielsen A, Teets R, Moonaz S, Anderson BJ, Walter E, Milanese M, et al. Group Acupuncture Therapy With Yoga Therapy for Chronic Neck, Low Back, and Osteoarthritis Pain in Safety Net Setting for an Underserved Population: Design and Rationale for a Feasibility Pilot. *Glob Adv Health Med.* 2020 Oct 18; 9:2164956120964716.
27. Roseen EJ, Gerlovin H, Femia A, Cho J, Bertisch S, Redline S, et al. Yoga, Physical Therapy, and Back Pain Education for Sleep Quality in Low-Income Racially Diverse Adults with Chronic Low Back Pain: a Secondary Analysis of a Randomized Controlled Trial. *J Gen Intern Med.* 2020 Jan;35(1):167–76.
28. Tankha H, Gaskins D, Shallcross A, Rothberg M, Hu B, Guo N, et al. Effectiveness of Virtual Yoga for Chronic Low Back Pain. *JAMA Netw Open.* 2024 Nov 1;7(11):e2442339.