Impact of Lumbar Instability on Physical Function and Balance in Subjects With Knee OA: An Observational Study

[1]Urmi Bhatt , [2]Dr. Yagna Shukla

[1]MPT (Musculoskeletal conditions), PhD scholar (Gujarat University), Assistant professor, C. U. Shah Physiotherapy College, Surendranagar, Gujarat, India.
[2]MPT, PhD (Physiotherapy), Senior Lecturer, Government physiotherapy college, Ahmedabad, Gujarat, India.

Abstract:

Background: Osteoarthritis(OA) of knee is one of the most common musculoskeletal disorders that increases global health burden. Various researches, aimed to improve pain and physical functions in individuals with OA knee have been conducted. Yet, there is dearth on researches evaluating coexisting lumbar instability and its impact on physical function limitation and risk of fall in individuals with knee osteoarthritis, whilst there is pool of researches on kinetic chain evaluation including lumbar spine for athletic population for injury prevention.

Methodology: 22 individuals with OA knee, age of 50-65 years (male or female) willing to participate in the study were included in the study. Demographic details including age, BMI (Body Mass Index), duration of knee pain were recorded. All the individuals were screened for presence of lumbar segmental instability (using passive lumbar extension test), balance (using Dynamic Gait Index), and physical function using mWOMAC.

Results: Data were analyzed using SPSS. There were significantly greater ($p<0.05$) deficits in balance and function of individuals with presence of clinical lumbar segmental instability. Additionally, BMI and Duration of knee pain also correlated positively with balance and function deficits in all individuals.

Conclusion: Presence of lumbar segmental instability in individuals with OA knee puts them on greater risk of fall due to altered balance and limits functional ability as well.

Clinical Implication: Such correlation between presence of lumbar instability and physical function and balance has important implications for rehabilitation of individuals with OA knee.

Key words: Knee Osteoarthritis, Lumbar instability, Balance, Physical Function

Introduction:

Osteoarthritis (OA) is a degenerative musculoskeletal disorder that can affect any joint, but commonly affects weight bearing joints of lower limb, especially hip and knee joint. OA is characterised by pain, stiffness and loss of normal joint function due to progressive cartilage destruction, osteophyte formation and joint inflammation. OA of knee imposes significant difficulty in locomotive tasks. Osteoarthritis of knee is a leading cause of pain and locomotor disability in elderly population.[1]

Non surgical management of knee OA as recommended by Osteoarthritis Research Society International (OARSI), includes biomechanical intervention, patient education, strength training and weight management as the most appropriate therapy to manage symptoms of knee OA. Detailed analysis of gait & balance is of utmost importance while undertaking multi-factorial treatment approach in management of degenerative joint arthritis.[2]

Most individuals with knee OA manage locomotive activities by compensatory changes in gait, posture and transfer activities. Commonly reported gait adaptations in individuals with knee OA include, increased lateral trunk lean, increased anterior tilting of pelvis and increased step width.[3] These adaptations appear to reduce loading of painful arthritic limb and allows the individual to cope up with activities of daily living.[4]At the same time, these adaptations, appear to increase the mechanical cost of ambulation, fall risk and loading the proximal joints.[5]

Individuals with knee OA frequently suffer from chronic low back pain, which is usually degenerative in nature and seem to be secondary to adaptive changes in locomotive activities. Any chronic low back pain, without obvious history of trauma or exact cause is frequently caused by underlying segmental instability.[6,7] Lumbar segmental instability, mechanical or functional has been shown to be an important risk factor for injury and predictor of poor performance in various sports population.[8,9]

Lumbar segmental instability, physical function and balance can be assessed easily using various clinical tests or scales in individuals with knee OA in physiotherapy out patient department.

Presence of lumbar instability can be accurately assessed by various clinical signs and physical tests. Various clinical tests can be used to detect lumbar instability, such as prone instability test, passive lumbar extension (PLE) test, aberrant movement test, posterior shear test, and active SLR test. Among these tests, passive lumbar extension test is the most reliable and validated test to detect presence of lumbar instability. PLE is a very easy to administer and quick test that can be used to detect lumbar instability in individuals with knee OA.[10]
Physical function in individuals with knee OA can be accurately assessed by modified WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index). Modified WOMAC is the most widely accepted, self administered questionnaire which is validated in Gujarati language as well.[11]
Balance affection in all geriatric disorder is related to changes in gait, impairments in which can be assessed by Dynamic Gait Index (DGI).[12]
Clinical assessment and analysis of correlation among physical function, balance and presence of lumbar instability can give meaningful insight to design rehabilitation programs for individuals with knee OA.
Till date no studies have been undertaken to examine effect of lumbar segmental instability on physical function and balance in individuals with knee OA. Aim of the present study is to see the impact of lumbar instability on physical function and balance in individuals with knee osteoarthritis.

Methodology:

The study was conducted at institutional musculoskeletal physiotherapy department after obtaining ethical approval. 22 individuals with knee OA, within age group of 50-65 years (male or female), willing to participate in the study were included in the study based on selection criteria. Individuals were not included in the study, if they had any neurological or cardiac problems and history of trauma to spine or lower limbs, visual or hearing impairments and history of fall in past one year. Written informed consent was taken from all the individuals before obtaining any data. Demographic details including age, BMI (Body Mass Index), duration of knee pain (in months) were recorded.
Afterwards, all the individuals were screened for presence of low back pain and presence of segmental instability (using passive lumbar extension test). For passive lumbar extension test, patient is placed in prone lying position. The therapist elevates patient's legs to a height of approximately 30 cm without bending the knees. If the patient complains of pain in low back region during the test, it is considered positive and indicates presence of lumbar segmental instability.[10]

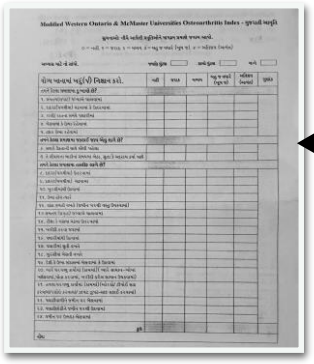


Figure 1. mWOMAC scale in gujarati

Figure 2. Patient performing DGI

Based on presence or absence of lumbar instability (positive or negative passive lumbar extension test), individuals were divided into two groups: Group A (n=10,Without Instability) and Group B (n=12, With Instability).
Afterwards, assessment of levels of pain using Numerical Pain Rating Scale (NPRS) and physical function was done using mWOMAC in all the individuals of both the groups. Modified WOMAC is a self administered questionnaire (fig.1), that comprises of 24 questions divided into three sub scales: Pain (five items), stiffness (two items) and physical function (17 items). Each question is scored on a scale of 0-4, which corresponds to None (0), Mild (1), Moderate (2), Severe (3), and Extreme (4). The mWOMAC takes less than 10 minutes to complete, and can be taken on paper or over the telephone or computer. Higher the scores on mWOMAC, worse the pain and functional limitations.[11]
Assessment of balance was done using Dynamic Gait Index in all the individuals of both the groups.
The DGI tests (fig.2) the ability of the participant to maintain balance while walking and responding to different tasks during walking, throughout the test. Participants are asked to walk on a ten meters walkway with eight different tasks. The eight items are: walking on level surfaces, altering speeds, head turns in horizontal and vertical directions, walking and turning 180 degrees to stop, stepping over and around obstacles, and stair ascent and descent. Each of this task is scored on a scale of 0 to 3, where 3 indicates normal performance and 0 indicates severe impairment. Test takes approximately 15 minutes to complete.[12]

Results:

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 20. The data were screened for presence of normal distribution, before applying any statistical tests. The confidence interval was 95% and level of significance was kept at 5% for all the tests. Table one shows demographic details and characteristics of all partcipants. Both the groups were compared for age, BMI and duration of knee pain to see if the data were equally distributed in both the groups or not. BMI, and duration of knee pain(in months) of both the groups were compared using unpaired t-tests, while pain levels (NPRS) were compared using Mann-whitney U test (Table 2). Modified WOMAC and DGI scores of both the groups were compared using unpaired t-tests (Table 2 and fig.4). There were significantly greater ($p<0.05$) deficits in balance and function of individuals with presence of clinical lumbar segmental instability. A correlational analysis was made between BMI, levels of pain, duration of knee pain and physical function and balance (Table 3 and fig.5). Duration of knee pain correlated moderately, yet significantly with mWOMAC ($r=0.45$, $p<0.05$) and no correlation was found between duration of knee pain and DGI. NPRS correlated moderately, yet significantly with DGI ($r=0.41$, $p<0.05$) and no correlation was found between NPRS and mWOMAC.

Table 1: Demographic details and characteristics of participants

Charactristic	Mean value for Group A (Without lumbar instability)	Mean value for Group B (With lumbar instability)
BMI (Kg/m^2)	26.22	28.98
Duration (In months)	17.9	22
NPRS	4.6	5.5
mWOMAC	36.6	51.33
DGI	17.7	11.58

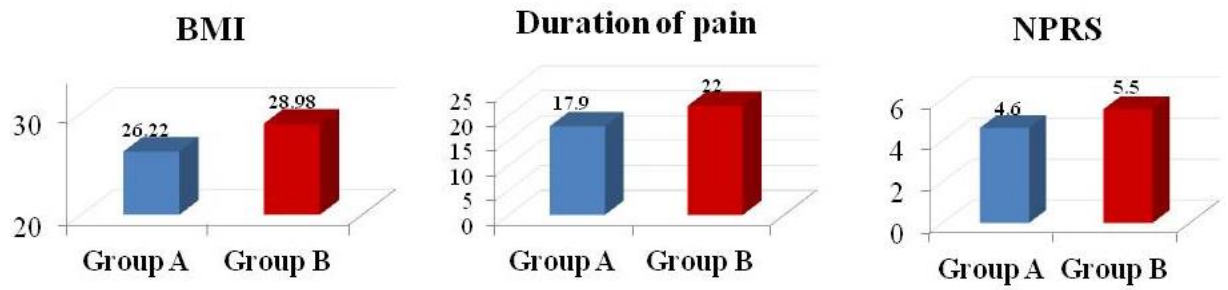
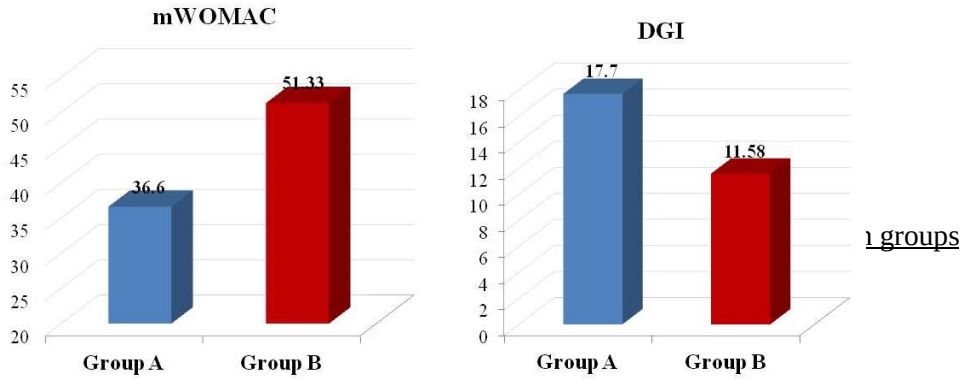


Table 2: Tests and their interpretation

Outcomes	Tests used to compare Groups A & B	t/ U value	P value	Significant
mWOMAC	Unpaired t test	-2.29	**0.03**	**Yes**
DGI	Unpaired t test	4.44	**<0.01**	**Yes**
NPRS	Mann Whitney U test	35.5	0.091	No
BMI	Unpaired t test	-1.65	0.113	No
Duration	Unpaired t test	-1.025	0.318	No



ı groups

Figure 4. Comparison of mWOMAC and DGI scores of Group A & B

Table 3: Correlation between BMI, Duration of knee pain, NPRS and mWOMAC and DGI

Spearman/ Pearson	BMI		Duration of knee pain		NPRS	
	r	p	r	p	r	p
mWOMAC	0.492	**0.02**	0.457	**0.03**	0.207	0.35
DGI	-0.448	**0.03**	-0.375	0.08	-0.413	**0.04**

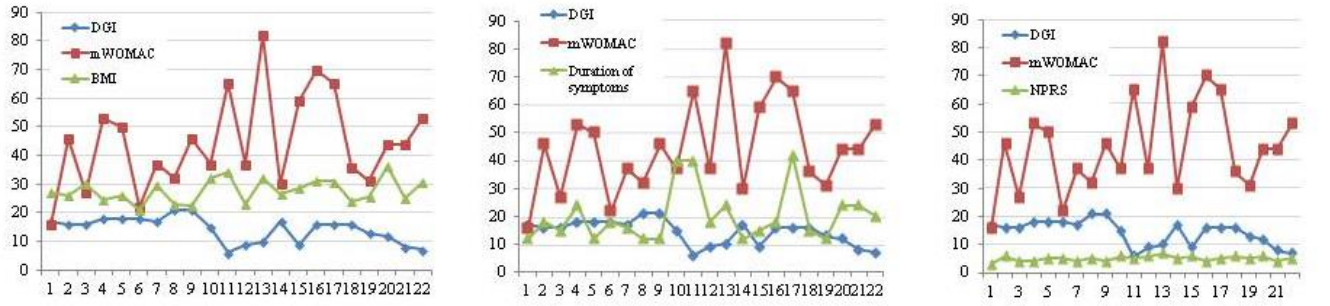


Figure 5. Graphical presentation of correlation between BMI, Duration of knee pain, NPRS and mWOMAC and DGI

Discussion:

The results of present study indicates significant impairments in physical function and balance in knee OA subjects with lumbar segmental instability as compared to those without lumbar instability. The study found a moderate yet significant correlation between BMI and physical function as well as balance in knee OA subjects. The study also showed moderate yet significant correlation between pain levels and balance, which is in accordance with previous researches. The study also found moderate correlation between duration of symptoms and physical function.

The correlation between higher BMI and physical functions and balance can be explained by effect of obesity on over all health of an individual. Various researches have linked higher BMI with poor physical function and balance in knee OA population.[13] Higher BMI may cause increased mechanical loading of all the joints, including knee joint, as well as it accelerates inflammatory process due to altered metabolism.[14] Obesity causes forward shifting of centre of gravity and challenges balance further. This increases mechanical cost of daily living activities and further increases loading of lower limb joints and leads to greater difficulty in marinating balance and loss of physical function.

The study also showed moderate yet significant correlation between pain levels and balance, which is in accordance with previous researches.[15] According to a study by Docyung and others[15], more painful knee is associated with weaker quadriceps, reduced lower limb function and reduced balance. Pain can cause reflex inhibition of quadriceps muscle and thereby may alter with locking mechanism of knee. Deficient locking mechanism of knee may predispose an individual to frequent falls due to loss of balance. Hence, though arthritic knee pain is chronic in nature and has behavioural components, it is an important symptom that can interfere with balance of elderly and must be addressed adequately during rehabilitation.

The correlation between duration of symptoms and physical function can be explained by the degenerative nature of the disease. As the disease duration increases, it leads to progressive deficits in muscle strength and joint function, which can adversely affect the functional status of the individual (fig.6).

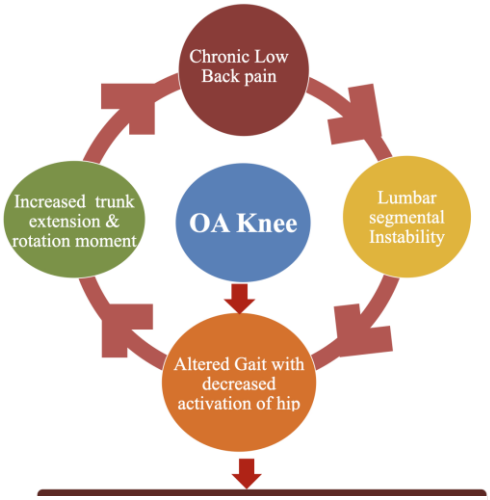


Figure 6. Cascade of degeneration: from Knee to spine via alterations in

Significantly greater deficits in balance and physical function in subjects with knee OA with lumbar segmental instability can be explained by a direct mechanical link between spine and the lower extremities. Lumbar spine and pelvis serves as a stable proximal base around which both the lower limbs swing like a pendulum during normal level walking. If the proximal segment is not rigid, and shakes easily upon weight shifts, it will increase energy consumption during day to day activities and this in turn will challenge the balance as well.

The finding of current study are in accordance with numerous previous research that has identified lumbar segmental instability as an important cause of injury in young athletic population. Lumbar Segmental stability has been shown to be linked with lower extremity function and injury secondary to loss of balance in various population. Lumbar segmental stability or core stability is the ability of the lumbopelvic hip complex to prevent buckling and to sustain equilibrium after perturbation. Lumbopelvic complex also provides a feedforward control to prepare for upper or lower limb moment productions.[16,17] Hence, identifying and addressing lumbar segmental instability in OA knee individuals is very important to improve function and balance.

Conclusion:

Present study indicates greater deficits in balance and limitations in physical function in OA knee individuals with lumbar instability. Future studies addressing lumbar segmental instability can give meaningful insight in rehabilitation of OA knee individuals. Findings of the study also indicate that higher BMI, higher pain levels and higher duration of symptoms can be contributors to reduced physical function and altered balance in OA knee individuals.

Acknowledgement:

The authors are greatly thankful to all the participants for their enthusiasm and valuable time for the study and to the management of C. U. Shah Physiotherapy college, Surendranagar, for their constant support and keen interest in research activities.

Conflict of interest: NIL

References:

1. Kloppenburg M, Berenbaum F. Osteoarthritis year in review 2019: epidemiology and therapy. Osteoarthritis Cartilage. 2020;28(3):242–8.
2. Bannuru RR, Osani MC, Vaysbrot EE, Arden NK, Bennell K, Bierma-Zeinstra SMA, Kraus VB, Lohmander LS, Abbott JH, Bhandari M, Blanco FJ, Espinosa R, Haugen IK, Lin J, Mandl LA, Moilanen E, Nakamura N, Snyder-Mackler L, Trojian T, Underwood M, McAlindon TE. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. Osteoarthritis Cartilage. 2019 Nov;27(11):1578-1589.
3. Mills K, Hunt MA, Ferber R. Biomechanical deviations during level walking associated with knee osteoarthritis: a systematic review and meta-analysis. Arthritis Care Res (Hoboken). 2013;65(10):1643–65.
4. Metcalfe AJ, Stewart C, Postans N, Dodds AL, Holt CA, Roberts AP. The effect of osteoarthritis of the knee on the biomechanics of other joints in the lower limbs. Bone Joint J. 2013;95-B(3):348–53.
5. Bowd J, Biggs P, Holt C, Whatling G. Does gait retraining have the potential to reduce medial compartmental loading in individuals with knee osteoarthritis while not adversely affecting the other lower limb joints? A systematic review. Arch Rehabil Res Clin Transl. 2019;1(3–4):100022.
6. M. Rahbar, M. Shimia: Association between knee pain & low back pain; JPMA 2015: 626-632
7. Demoulin C, Distrée V, Tomasella M, Crielaard J-M, Vanderthommen M. Lumbar functional instability: a critical appraisal of the literature. Ann Readapt Med Phys. 2007;50(8):677–84, 669–76
8. McGill SM. Low back stability: from formal description to issues for performance and rehabilitation. Exerc Sport Sci Rev. 2001;29(1):26–31.
9. Leetun DT, Ireland ML, Willson JD, Ballantyne BT, Davis IM. Core stability measures as risk factors for lower extremity injury in athletes. Med Sci Sports Exerc. 2004;36(6):926–34.
10. Ferrari S, Manni T, Bonetti F, Villafañe JH, Vanti C. A literature review of clinical tests for lumbar instability in low back pain: validity and applicability in clinical practice. Chiropr Man Therap. 2015;23(1):14.

11. Khuman R, Chavda D, Surbala L, Bhatt U. Reliability and validity of modified western ontario and mcmaster universities osteoarthritis index gujarati version in participants with knee osteoarthritis. Physiotherapy. 2018;12(1):8
12. Herman T, Inbar-Borovsky N, Brozgol M, Giladi N, Hausdorff JM. The Dynamic Gait Index in healthy older adults: the role of stair climbing, fear of falling and gender. Gait Posture. 2009;29(2):237–41.
13. Wluka AE, Lombard CB, Cicuttini FM. Tackling obesity in knee osteoarthritis. Nat Rev Rheumatol. 2013;9(4):225–35.
14. Sowers MR, Karvonen-Gutierrez CA. The evolving role of obesity in knee osteoarthritis. Curr Opin Rheumatol. 2010;22(5):533–7.
15. Kim D, Park G, Kuo L-T, Park W. The effects of pain on quadriceps strength, joint proprioception and dynamic balance among women aged 65 to 75 years with knee osteoarthritis. BMC Geriatr. 2018;18(1):245.
16. Willson, John D., et al. Core stability and its relationship to lower extremity functionand Injury: Journal of the American Association of orthopaedic surgeons, 2005, vol.13, issue 5, 316-325.
17. Jull, GA, Richardson, CA: Rehabilitation of active stabilization of the lumbar spine. In Twomy, LT, Taylor, JR (eds) Physical Therapy of the Lumbar Spine, ed 2. Churchill Livingstone, New York, 1994.