ijcrr
Vol 04 issue 05
Category: Research
Received on:23/01/12
Revised on:01/02/12
Accepted on:07/02/12

DOES PROLONGED SITTING WORK AMONG MIDDLE AGED WOMEN IMPAIR KNEE JOINT POSITION SENSE? A COMPARATIVE STUDY

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ABSTRACT

Objectives: Work, when performed in prolonged sitting position can have an impact on knee joint position sense (JPS) due to altered weight transmission and may contribute to early degeneration of knee joint. However no literature is available that compares the knee JPS between the women involved in prolonged sitting type of job to non-working women. Hence this study compares theknee JPS between working and non-working women to find the impact of prolonged sitting.-**Materials and Methods**: Knee JPS was measured in both knee joints by active repositioning method with a standardized goniometer in terms ofabsolute and relative error on 80 subjects (40 in each group). Subjects were selected through random convenient sampling. **Result**: There were no significant differences in-terms of both absolute and relative error between the groups (P< 0.05) in both the knees. **Conclusion**: This is the first study (to the best of our knowledge)`which has analysed the position sense error between the working and non-working women group. It was found that prolonged sitting has no influence on knee JPS and this could be a least contributing factor for the development of the knee joint degeneration in any women at 40-50 years of age.

Keywords: Knee joint position sense, middle aged women, degeneration, prolonged sitting.
Running title: Does prolonged sitting impair knee JPS?

INTRODUCTION

Work, when performed in awkward postures or with excessive effort, may result in fatigue and discomfort, leading to micro trauma of the surrounding structures.[1]It can be controlled by identifying workplace stressors and managing them by adopting morenormal ergonomic sitting pattern.[2]

Proprioception is defined as, ‘the ability to detect, without visual input, the spatial position and/or movement of limbs in relation to the rest of the body’.[3,4] The physiological systems that contribute to proprioceptive acuity include visual and vestibular systems, articular, cutaneous and muscle mechanoreceptors which finely controls muscle contraction; enabling smooth, coordinated movements.[5]

The role of the proprioception has become increasingly important as proprioceptive deficiency facilitates the injury, [6] and may lead to poor control and greater mechanical load on the joint, which in turn leads to an increased risk of development of degenerative changes in the joint.[7]Proprioception is affected by factors such as age, physical activity, muscle fatigue and degenerative arthritis of the joint.[3, 4]

Any activity that puts excessive weight-bearing force across the joint, after activities like prolonged squatting, sitting, and standing;affects the protective stabilizing mechanisms of proprioception and may initiate or contribute to the abnormal joint forces and hence to the degenerative changes in a joint.[8]

The knee joint is one of the largest and most complex synovial joint of the body having predominant dynamic functions.[9]The degenerative joint disease (DJD) of knee joint is a leading cause of disability among the middle aged women in India and its impact on the public health is substantial.[10]

The risk of developing the proprioceptive deficits in the knee joint in middle age can be attributed to the occupation to an extent. It has been estimated that the jobs involving prolong bending, squatting, standing and sitting predisposes to structural damage to the knee joint.[11]A study had reported that approximately 27% office workers are prone for knee joint degeneration because of their sitting type of job.[12]

The relative prevalence of arthritic changes among white collar professionals in age group 20- 59 years was 0.1 and prolonged sitting may be a risk factor with the relative risk of 1.1 (odds ratio).[13] However, this was not a major risk factor for degenerative changes over the knee joint and the white collar professionals were considered as 'low risk group' for developing degenerative changes in the knee.[11, 13]

The evidences have concluded that impaired proprioception is involved in the early degenerative changes in the knee joint[7]during active life. Therefore early detection of the degenerative changes in terms of joint position sense deficits is key to develop preventive measures in the workplace to reduce knee pathologies in the community.[13] However; the available studies related to this subject are very much limited. So we planned to trace the patho-physiology of degenerative changes in the knee joint, in terms of joint position sense errors, which we hypothesized to be affected in women, who is involved in seating work environment for a prolonged period.

MATERIALS AND METHODS

This study was approved by the Time-Bound ethical committee, KMC, Mangalore (Ref No: (IEC/KMC/03/2010-2011) before its commencement. A total of 106 subjects were screened (working and non-working) from the banks, offices and community through physiotherapy camps in and around Mangalore. Working women included women who are involved in desk job, who sits on an average of 7 hrs/day (a pilot study was carried-out before the commencement of this study and 7 hrs was identified as average time of working).

Through this process 80 subjects (40 in each group) were included as per inclusion and exclusion criteria proposed for the study. Rest 26 were excluded as 8 subjects had knee pain, knee joint crepitus and early arthritic changes, 7 were working in small scale industry at home, 5 subjects had underwent hysterectomy, 3 were asthmatic, 2 had history of seizures, and 1 had undergone TKR. The sample size was calculated with the formula $\{(Z\alpha+Z\beta)^2.\sigma^2\}/\delta^2$,where $Z\alpha$ and $Z\beta$ value is 1.96 and 1.28 respectively.

A written informed consent was obtained from all 80 subjects after explaining the study procedure and purpose. The demographic details were obtained and subjects were assessed by the following procedure for the knee joint position sense.

Testing Procedure for Knee Joint Position sense:

Subjects were made to sit on a high couch with folded towels placed behind the lower thigh so that it appears horizontal, having 90° angle with trunk at hip joint. The relaxed knee (i.e. Tibia) assumed right angle with the hip (i.e. Femur). Reference mark was applied on the lateral aspect of the testing knee joint. A transparent degree-calibrated clinical goniometer was placed in a manner that the proximal arm orienting along the long axis of the femur and distal arm along the tibia.

Subjects relaxed and eyes open; examiner lightly grasped the foot and passively extended the knee from the resting position (~90° flexion) to the chosen test position- which was unknown to the subjects. Then the subjects were blindfolded and the same procedure was repeated. The knee was kept in the selected test position for ~4 s. At this time the subject was asked to perceive their knee position. Next the examiner re-supported the foot and lowered the relaxed leg to the initial resting position.

Now the subjects were then asked to actively extend the knee to the perceived test position, and to hold in this response position for ≥ 5 sec and the goniometric measurement of joint position sense in degrees was obtained. Finally, the foot was re-positioned back to the initial resting position by the subject. Two practice sessions were done with eyes open and closed. The procedure was carried on at three angles of extension 45º, 60º, and, 80º randomly selected by chit method by the subject. 30 seconds of rest was given and the subject was asked to reproduce the perceived position after blinding. Three trials for each angle were done. The differences between the target and estimated angle were noted down, and the relative and absolute error was calculated.

Statistical analysis:

For statistical analysis, data was interpreted with the Statistical Package for Social Science (SPSS) version 13.0. The level of significance of < 0.05 was considered to be statistically significant with 95% confidence interval.

- Unpaired T-test was used for the comparison of BMI and age, for both the groups (working and non-working).
- Mann-Whitney U test was used for the comparisons of the absolute and relative errors between the groups.
- The correlations between the variables like BMI, age, menopausal history were evaluated with Pearson's correlation test.

RESULT

The working and non-working groups comprised of 40 females each had age range of 40-50 years. The mean age and BMI of both the groups are shown in table 1. There was no statistical difference between the groups with respect to age and BMI (p=0.19, 0.68 respectively).

To test the primary hypothesis, i.e. comparison between the knee joint position errors of the working and non-working group (table 2) the Mann-Whitney U test was used and there was no statistical significant difference between the groups in terms of the absolute and relative errors. The mean AE of working group was 6.623±5.04° and that of the non-working group was 5.665±4.95°. The mean RE of the working group was 2.84±8.13° and that of the non-working group was 2.46±7.185°.

In addition to the main hypothesis, the correlation of post and pre- menopausal history with the absolute and relative errors of both the groups was analyzed. The results are displayed in the table 3, which shows that there is no significant difference between the menopausal history and the errors in both the groups.

The age and the BMI of both the groups were compared with the errors and the following findings were obtained: (table 4)

a) The age and the errors of both the groups combined did not show statistical significance (p= 0.409)
b) The relative errors on right side at 60°,80° and left side at 80° had a weak positive correlation with the BMI with p values 0.031, 0.012 and 0.041 respectively.

The absolute and relative errors within the groups were analyzed and the correlations between AE and RE of the right and left side were observed. The AE of right side at 45° and 60° strongly correlated with AE and RE of left side at 45°, 60° respectively. And RE of right side at 60° strongly correlated with RE of right side 80°, left 60°, 80°. Other strong positive correlations between errors of different angles are given in table- 5.

DISCUSSION

Joint position sense may be impaired in case of decreased feedback from the joint receptors in case of prolonged non-weight bearing positions when adopted e.g. seated office work.[11,12,14] The impaired position sense could be a contributing factor for the initiation of early stage of structural damage in the knee rather being secondary to the disease.[7] Also because the progressive development of articular surfaces degeneration of knee joint is solely not the disease of aging, but potentially have etiological link with the occupation.[12]

The aim of the study was to determine the differences in knee joint position sense among working and non-working middle aged women to see the scientific basis of posture related changes and to detect the development of early signs of degenerative changes in the joint. Hence the age range of 40 - 50 yrs was considered for the study, since the degenerative changes in the joints among women sets in at 51 yrs of age on an average;[12] and the average age at which osteoarthritis becomes clinically symptomatic, was found to be 59-60 years for females involved in desk job.[12]

In this study the age and BMI of the subjects of both the groups were not statistically significant, (p= 1.31, 0.68) suggesting that the confounding factors were controlled.

Our understanding while designing the study was that there will be subtle differences in knee joint position sense between working and non-working females, since working women would have probably uniform sitting pattern for a fixed number of hours compared to the non-working subjects. But the results indicated that in this age range, among both the groups, changes in the joint position sense at all angles were relatively equal; Average AE of working women was 6.624°±5.033° and non-working was 5.665°±4.957°. Average RE of working women was 2.84°±8.13° and non-working women was 2.46°±7.185° ($p<0.05$). Such differences in joint position sense are statistically insignificant. These changes are also clinically insignificant (minimal clinical difference was found to be 5° in a previous study[12]) suggesting that, both groups activity levels did not have any influence on knee joint position sense in this age range. However 40 - 50 years can be considered as a healthy age range, therefore we can assume that the individual may not demonstrate any initiation of changes in terms of position sense error, which can begin the process of degenerative changes physiologically.[12]

In this study we observed that the speed at which the subjects adopted to reposition their joints was not uniform among the subjects. Literature indicates that slower velocity can influence the position sense capacity negatively even in healthy individuals.[15] But the velocity at which the joints were repositioned was not analyzed. Therefore we cannot attribute that the velocity would have any influence among the groups in order to have their joint position sense relatively uniform.

Furthermore, both the AE and RE was found to be relatively uniform (larger) in the right knee at 45°, and left knee at 60° in both the groups. Such uniformity was more in the right compared to left, this we attribute on limb dominance factor. But when analysis was done for specific angle, we noticed that at 80°, the errors were less in both the knees. This result is in favor of the previous studies, where authors had concluded that articular afferents discharge maximally at the extremes of joint movements, and are also active within the joint's midranges.[16]

We also analyzed the effect of menopause on joint position sense error, which was found to have no correlation; this indicates that in this age range menopause do not affect the joint position sense. Since the effect on musculoskeletal changes for women begins at the age of 51 years, therefore similarities were detected between the post and pre-menopausal groups with respect to joint position sense error.

The uniqueness of this study was that AE and RE demonstrated good correlation at 45° and 60° for both right and left knees respectively. This suggests that in future, the AE and RE terms can be used interchangeably at these angles for the knee joint position sense error.

The limitations of the study were non consideration of joint velocity on position sense error, influence of lifestyle (mode of transport) and psychosocial aspects (stress levels). This study also does not involve gender comparison to know which gender would have demonstrated more differences in joint position error with same working nature.

Suggestions for further research:

- Comparison of joint position sense error between working females and males;
- Use of more precise objective tools e.g. electro-goniometer, to measure position sense errors among same age range and subject type;
- The same study in small age cohorts with 2 years band from 50 - 51,51 - 52…… to know at what age actual joint position sense declination occurs;
- Consideration of joint velocity using instruments like isokinetic dynamometerduring position sense detection.

Clinical outcomes of the study

- 40 - 50 years of age may not be the age when early signs of degenerative changes at knee to be detected;
- AE and RE can be interchangeably used at 45° and 60° for knee extension;
- Menopausal history may not have relation with the knee joint position sense for women between 40 - 50 years of age.

ACKNOWLEDGEMENTS

Our gratitude to the members of Lion's club, LIC office, Mangalore for their support rendered for bringing out the study.We acknowledge the immense help received from the scholars whose articles are cited and included in references of this manuscript. We are also grateful to authors / editors / publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

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Table:1 Age, BMI of the working and non-working group

characteristic	working group	non-working group	t-value	P-value
Age	45.65±3.409	44.63±3.607	1.31	0.195
BMI	28.02±5.689	25.71±5.471	1.85	0.68

*P<0.05

Table 2: Comparison of absolute and relative errors between the groups

Knee side	Angle	AE (degrees)				RE (degrees)			
		Working	Non-working	U-value	p- value	working women	non-working	U-value	p- value
Right	45	6.53± 5.429	4.90± 5.429	1.48	0.14	3.78± 7.979	2.70± 6.828	0.88	0.376
	60	6.33± 5.663	6.13± 4.847	0.09	0.927	3.38± 7.837	2.68± 7.392	0.28	0.776
	80	5.43± 3.928	6.08± 5.913	1.34	0.18	-0.28± 6.748	1.78± 7.546	1.14	0.255
Left	45	6.075± 5.020	4.73± 4.399	2.65	0.08	4.70± 9.045	2.83± 6.946	1.79	0.73
	60	7.98± 5.442	6.20± 5.254	1.61	0.108	4.98± 8.334	3.55± 7.355	0.98	0.326
	80	7.40± 4.717	5.95± 3.902	1.26	0.207	0.5± 8.855	1.20± 7.075	0.31	0.754

*P<0.05

Table 3: correlation of menstrual history with absolute and relative errors

LS	TA	working								Non- working							
		AE				RE				AE				RE			
		Pre-MP	Post-MP	U value	p-value	Pre-MP	Post-MP	U value	p-value	Pre-MP	Post-MP	U value	p-value	Pre-MP	Post-MP	U value	P- value
Rt	45	6.58± 5.633	6.44± 6.429	0.182	0.856	4.00± 7.763	3.44± 8.540	0.389	0.697	4.69± 4.913	5.28± 6.462	0.072	0.943	2.62± 6.319	2.86± 7.941	0.699	0.485
	60	5.71± 5.820	7.25± 5.541	1.168	0.243	4.63± 6.749	1.50± 9.143	1.179	0.238	6.19± 5.012	6.00± 4.707	0.100	0.920	2.65± 7.594	2.71± 7.279	0.057	0.955
	80	4.96± 4.349	6.13± 3.202	1.127	0.260	-1.13± 6.576	1.00± 7.014	1.121	0.262	4.65± 5.491	7.43± 4.450	1.705	0.88	2.42± 6.825	0.57± 8.881	0.356	0.721
lt	45	8.42± 6.128	7.63± 6.217	0.485	0.628	5.33± 9.044	3.75± 9.256	0.664	0.507	4.54± 4.917	5.07± 5.553	0.171	0.864	2.54± 6.237	3.36± 8.335	0.142	0.887
	60	8.29± 5.29	7.50± 5.795	0.572	0.572	6.04± 7.855	3.38± 9.025	1.003	0.316	6.69± 5.823	5.29± 4.027	0.171	0.864	4.31± 7.822	2.14± 6.431	0.698	0.485
	80	6.92± 4.754	8.13± 4.717	0.727	0.467	0.8± 8.516	0.00± 9.626	0.513	0.608	5.31± 3.415	7.14± 4.572	1.199	0.230	1.46± 6.224	0.71± 8.677	0.43	0.966

*P<0.05

(LS- Limb side; TA-Target angle; AE- Absolute Error; RE- Relative Error)

Table 4: Correlation of age, BMI with errors

error	age		BMI	
	r-value	p value	r-value	p value
A.E rt 45	0.112	0.323	0.024	0.834
A.E rt 60	0.07	0.54	0.104	0.359
A.E rt 80	0.04	0.723	0.052	0.647
A.E lt 45	0.167	0.139	0.055	0.63
A.E lt 60	-0.005	0.966	0.026	0.818
A.E lt 80	0.075	0.51	0.085	0.452
R.E rt 45	0.132	0.242	-0.073	0.521
R.E rt 60	-0.083	0.465	0.241	0.031
R.E rt 80	-0.101	0.371	0.279	0.012
R.E lt 45	0.14	0.216	-0.005	0.964
R.E lt 60	-0.083	0.463	-0.164	0.145
R.E lt 80	-0.113	0.317	0.229	0.041

*P<0.05

Table 5: Correlation between the errors

Error 1	Error 2	r-value	p-value	Error 1	Error 2	r-value	p-value
A.E rt 45	A.E lt 45	0.912	0.000	**R.E rt 45**	R.E lt 45	0.942	0.000
	R.E rt 45	0.617	0.000	**R.E rt 60**	R.E rt 80	0.51	0.000
	R.E lt 45	0.559	0.000		R.E lt 60	0.926	0.000
A.E rt 60	A.E lt 60	0.841	0.000		R.E lt 80	0.508	0.000
	R.E rt 60	0.517	0.000	**R.E rt 90**	R.E lt 60	0.484	0.000
	R.E lt 60	0.515	0.000		R.E lt 80	0.821	0.000
A.E rt 80	R.E lt 80	0.665	0.000	**R.E lt 45**	R.E lt 60	0.335	0.000
A.E lt 45	R.E rt 45	0.566	0.000		R.E lt 80	0.499	0.000
	R.E lt 45	0.51	0.000	**R.E lt 60**	R.E lt 80	0.497	0.000
A.E lt 60	R.E rt 60	0.635	0.000				
	R.E lt 60	0.661	0.000				

*P<0.05

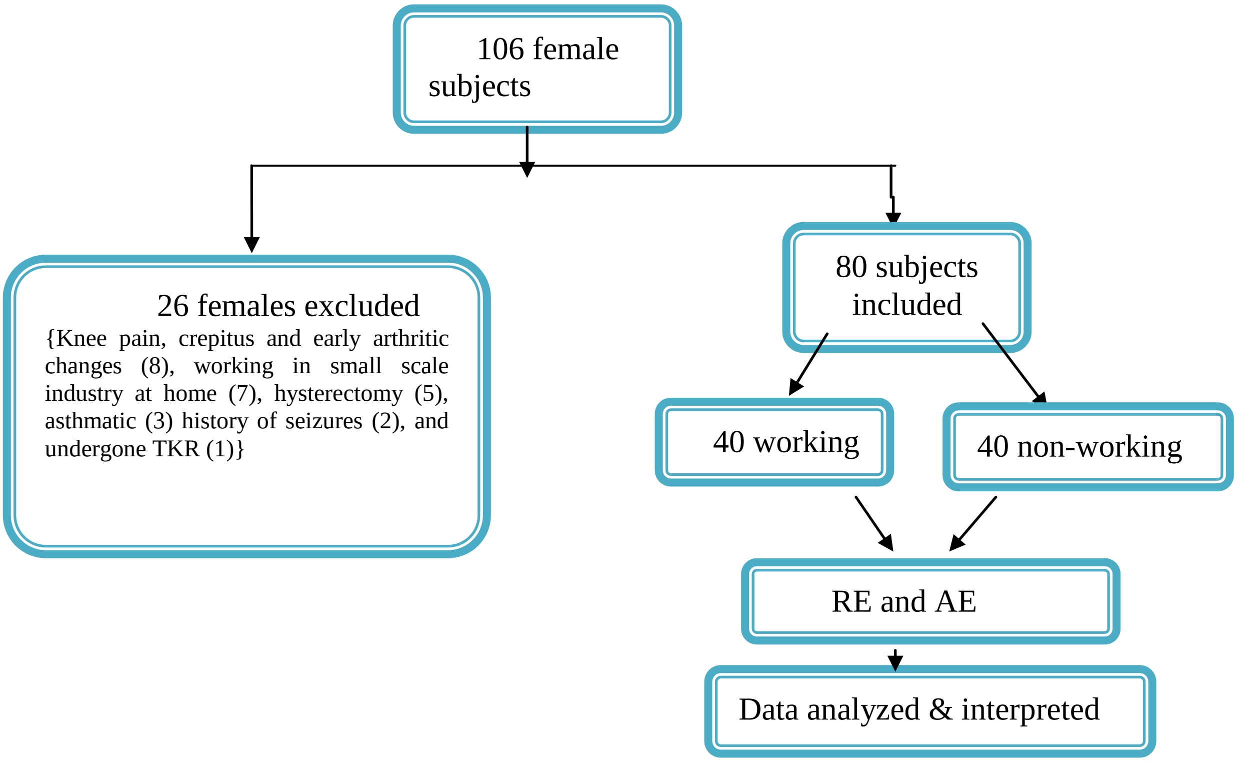

Figure 1: Methodology of the study

Figure 2: Alignment of the Goniometer