Original article

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Effect of Retro-Treadmill Ambulation Training in Patellofemoral Pain Patients

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Abstract

Objective: Patellofemoral pain syndrome (PFPS) is defined as the presence of pain around the patella, The goals of patellofemoral rehabilitation are to maximize quadriceps strength.. Backward locomotion may be a useful rehabilitation modality in the treatment of patellofemoral pain syndrome.

Methods: Study was conducted on 26 subjects for a period of 4 weeks in two groups. Outcome measures of pain and function were taken to assess the effect of intervention.

Conclusion: Statistically significant improvements in pain and function outcome measures in the patients with patellofemoral pain following intervention comprising of backward walking on treadmill indicate its effectiveness when incorporated as a therapeutic regime in these patients and is therefore recommended in the rehabilitation of PFPS patients.

Keywords: PFPS; Backward walking; Retro treadmill.

Introduction

Anterior knee pain is one of the most common conditions seen in outpatient However it has been suggested that backward walking may offer some benefits beyond those experienced through forward walking alone [7]. Graded walking provides a functional exercise that improves muscular activity around the affected joints, employs an appropriate range of motion and provides a controlled environment which minimizes the possibility of further damage.[8]

Flynn [9] reported significantly lower peak knee extensor moments and peak patellofemoral compressive forces in backward vs. forward running. Thus backward running may be a useful rehabilitation modality in the treatment of patellofemoral pain syndrome. According to Cipriani and Grasso backward running has been documented to increase quadriceps strength and power [10 11.] However there has not been any clinical trial conducted to support or refute the positive effects of backward treadmill walking in altering pain and physical functions in subjects with patellofemoral pain. Thus the purpose of this study is to examine the effects of uphill backward treadmill walking in altering pain and physical functions in subjects with patellofemoral pain syndrome.

Thorstensson [12] and Sang Wan Hang [13] also concluded that the effects of forward walking and backward walking on surface EMG analysis of Quadriceps at treadmill grades of 0%, 5%, and 10%. The results of their study indicated that SEMG activity levels of rectus femoris,vastus lateralis, and vastus medialis obliqus were significantly different between directions.

Methods

Design

Pre-test-posttest experimental design was used in this study.

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Subjects

Subjects were included on following inclusion criteria: age 18 to 35 years. Both males and females, history of retro or peri patellar pain during physical activities including jumping ,squatting, running, or stair ambulation or after prolonged sitting with flexed knees, symptoms for atleast two months,presence of at least one of the following clinical signs: tenderness on palpation or compression of patella, pain on isometric quadriceps contraction against supra-patellar resistance, pain on resisted knee extension, non-traumatic onset of symptoms, negative findings on clinical examination of knee ligaments, menisci, bursae (inflammation), iliotibial band (friction syndrome), negative findings on radiographs of the knee (AP and skyline views) with regards to changes of the osteoarthritis,osteochondritis dissecans,or loose bodies in the patellofemoral and tibiofemoral joints. Subjects were excluded if H/O any recent knee surgery, history of patellar subluxation or dislocation, severe knee pain that preclude treadmill walking(VAS equal to greater than 8),cardiopulmonary conditions that preclude treadmill exercise, neurological disorders affecting gait of the individual, significant injury to or any other pathology of hip,ankle,rheumatic disease affecting musculoskeletal system or sensorimotor performance

Procedure

A total of thirty two subjects were screened with the help of history taking and clinical examination for inclusion. Twenty six subjects met the inclusion criteria.A detailed explanation about the procedure was given. The subjects were then randomly allocated into either of the two groups: the intervention group or the control group. Demographic data and dependent variables were recorded. Measurement of function(KPS score) the Kujala scale is a self administered questionnaire (valid and reliable). Measurement of pain (vas): the pain levels of the patient were assessed using visual analog scale (VAS).. Both pre- and post-intervention measurements were taken. If the patient scored lesser post –intervention as compared to pre-intervention, it means that the patient responded well to the interventions as his pain levels reduced. After randomization pre-intervention measures were taken. Each group respectively underwent an intervention for four weeks depending upon their designated group. Subjects in group one received retro walking intervention and subjects in the second group i.e. control group received conventional quadriceps exercises.

Experimental group

All the subjects who were allocated to the retro walking intervention group were first familiarized with the backward walking pattern on the level ground such that during backward walking the toes strike the ground first instead of the heel .subject was asked to walk in backward direction for 2-3 rounds over ground. Then the patient was made to stand on the treadmill and face in the direction opposite to the direction of the moving belt of treadmill such that retro walking movement occurred. The subject began a practice session (10 min) on the treadmill consisting of backward walking initially holding the hand rails bilaterally and walking at a comfortable slow speed..Within this period the subject was instructed to remove the support from the hand railings, and for safety concerns the safety knob was hooked to the subjects clothes. The following protocol was used:

Speed(MPH)	INCLINE	Time(min.)
2.5	0%	5
2.5	3%	2
2.5	0%	2
2.5	5%	2
2.5	0%	2
2.5	10%	2

Pre-intervention measurement: pre intervention measurements for the VAS and KPS were taken at first day of intervention. Control group: the control group subjects

during the period of study were made to perform maximal isometric quadriceps tensioning and straight-leg raising exercises at once a day. Both exercises were performed in the supine position, with the knee in full extension, to minimize patellofemoral compression forces. The minimum demand for each session and both types of exercise was 3 sets of 10 contractions for 10-15 seconds. Thereafter the patients were advised to perform the conventional static quadriceps-stretching exercises.

Statistical analysis

Data analysis was done using SPSS software (version 10.5).Student's t test was used for in between analysis and paired t test was used for within group analysis for both the groups.

Results

On comparing baseline characteristics between two groups, no statistically significant difference was found between the two groups indicating that there is homogeneity in the groups at the baseline. The paired t-value analyzed for Kujala patellofemoral scale scores difference in the experimental group between the baseline and post 4 weeks of intervention (mean difference =11.17,S.D.=10.69) values showed significant difference at 0.01 level(P<0.01) indicating that there was marked improvements in function in the subjects with PFPS post retro treadmill intervention. the paired t-value analyzed for VAS (Worst) scores difference in the experimental group between the baseline and post 4 weeks of intervention (mean difference=3.43,S.D=1.07) values showed significant difference at 0.01 level ($p<0.01$) indicating that there was marked difference in the pain in subjects with PFPS post retro treadmill intervention. The level of significance was decided at $p<0.05$. the paired t-value analyzed for VAS (Worst) scores difference in the experimental group between the baseline and post 4 weeks of intervention (mean difference=1.97,S.D=0.64) values showed significant difference at 0.05 level ($p<0.05$) indicating that there was significant difference in the pain in subjects with PFPS with control conventional quadriceps exercises.

The paired t-value analyzed for Kujala patellofemoral scale scores difference in the control group between the baseline and post 4 weeks of intervention (mean difference =6.21,S.D.=4.21) values showed significant difference at 0.05 level($P<0.05$) indicating that there was marked improvements in function of the subjects with control group conventional quadriceps exercises.

Discussion

Knee extensor strength deficit is a common finding in patients with PFPS.[14,15] Quadriceps strengthening exercises have been used in the rehabilitation of PFPS, and "closed-chain" quadriceps strengthening or quadriceps strengthening in a weight-bearing position, has become an accepted method of treatment. Backward walking incorporates the closed chain concept of quadriceps exercise. Extended periods of backward locomotion are generally used by only for therapeutic or conditioning purposes.[16,17.] In recent years, Backward running has been popularized in the literatures a means to increase forward running performance, rest injured muscles.[18] Backward locomotion has gained popularity as a part of a program to rehabilitate certain knee injuries. Backward walking training or rehabilitation has been reported to decrease patellofemoraljoint compressive forces [19], to protect ACL from overstretching [20]and to decrease eccentric loading of the knee extensors.[21]

Researches has indicated that backward or retro walking can provide a number of benefits to patients suffering from patellofemoral pain, however no clinical trial till date has been undertaken to solidify or refute its place in rehab. When analysed within the group both the groups both the groups showed statistically significant

improvement in function and pain scoring. The subjects in the experimental group showed highly statistically significant improvement in Kujala patellofemoral scale and VAS during worst pain when compared between baseline and week 4. Rationale behind such significant effect could be that the rate of patellofemoral joint compressive force loading has been shown to be significantly slower, occurring in later period of stance phase during backward gait. Articular gait has viscoelastic properties that make it rate sensitive to loading so that it is more susceptible to injury during rapid loading which prevents sufficient accommodation.[17, 22.] Backward walking incorporates isometric and concentric nature of quadriceps activity, and backward running has been shown to increase concentric strength of the extensor mechanism. In addition rehabilitation protocols isometric and concentric training in the treatment of PFPS. Also in a recent study participants completed four weeks of backward walking on a treadmill for 10-15 minutes/day, four days/week. The sit and reach scores revealed that retro locomotion may be a practical means to improve flexibility of hamstrings[22]. Since hamstrings tightness has been shown to be frequently associated with PFPS. Thus, improved flexibility might have also contributed to improvements in the subjects.

Within the group the analysis, the subject in control group also showed significant improvements in pain, function scoring. This could be attributed to the performance of the home exercise regime by the control group subjects. These results are consistent with previous studies where the standard quadriceps exercises have resulted in significant improvements[23].

Between group analysis, both experimental and control group subjects improved pain and functional scores. However, on comparing both the groups it was revealed that the experimental group consisting of retro walking gained greater improvements in the outcome measures on week 3 and week 4.

The key to this difference could be that retro walking incorporates a closed kinetic chain or weight bearing rehabilitation. Weight bearing rehabilitation is more functional than non weight bearing exercises because they require multi joint movement, facilitate a functional pattern of muscle recruitment and stimulate proprioception[24]. It is also known that exercise exerts its effects on the brain through several mechanisms, including neurogenesis, mood enhancement, and endorphin release. For persons with chronic pain, exercise may decrease fear/avoidance beliefs, leading to increase function and improved conditioning[25].

Table I. Comparison of KPS Within Experimental Group

VARIABLE	DIFFERENCE MEAN	S.D	T VALUE
KPS0/KPSW1	0.001	3.21	0.221^{NS}
KPS0/KPSW2	1.30	6.06	0.519^{NS}
KPS0/KPSW3	5.71	9.07	8.67*
KPS0/KPSW4	11.17	10.69	12.38**
KPSW1/KPSW2	2.12	6.067	1.25^{NS}
KPSW1/KPSW3	6.21	9.08	9.68*
KPSW1/KPSW4	11.16	10.6	13.20**
KPSW2/KPSW3	3.21	6.66	9.33*
KPSW2/KPSW4	10.15	10.37	11.13**
KPSW3/KPSW4	5.27	7.90	6.73*

S.D: Standard Deviation

KPS: KUJALA PATELL OF EMORAL SCALE

*Significant at 0.05 level

**Significant at 0.01 level

Table II. Comparison of VAS Within Experimental Group

VARIABLE	DIFFERENCE MEAN	S.D	T VALUE
VAS0/VASW1	0.14	0.23	0.94^{NS}
VAS0/VASW2	0.30	0.61	2.23*
VAS0/VASW3	1.63	0.92	10.26*
VAS0/VASW4	3.43	1.07	12.80**
VASW1/VASW2	0.16	0.72	7.11*
VASW1/VASW3	1.49	1.02	9.61**
VASW1/VASW4	3.29	1.14	12.15**
VASW2/VASW3	1.33	0.74	2.11*
VASW2/VASW4	3.13	1.12	12.01**
VASW3/VASW4	1.80	0.79	7.87*

S.D: Standard Deviation

VAS: Visual Analog Scale

*Significant at 0.05 level

**Significant at 0.01 level

Table III. Comparison of VAS Within Control Group

VARIABLE	DIFFERENCE MEAN	S.D	T VALUE
VAS0/VASW1	0.012	0.42	0.52^{NS}
VAS0/VASW2	0.28	0.47	1.76^{NS}
VAS0/VASW3	0.61	0.67	8.41^{NS}
VAS0/VASW4	1.97	0.64	8.88*
VASW1/VASW2	0.23	0.43	1.41^{NS}
VASW1/VASW3	0.66	0.62	1.21^{NS}
VASW1/VASW4	1.04	0.74	9.46*
VASW2/VASW3	0.74	0.66	0.98^{NS}
VASW2/VASW4	1.51	0.64	9.65*
VASW3/VASW4	0.78	0.72	3.02*

S.D: Standard Deviation

*Significant at 0.05 level

Table IV. Comparison of KPS Score Between Two Groups

Variables	EXPERIMENTAL GROUP(N=13)		CONTROL GROUP(N=13)		t VALUE
	MEAN	S.D.	MEAN	S.D	
KPS0	68.91	7.67	69.10	10.68	0.30^{NS}
KPSW1	68.92	7.67	69.10	10.68	0.30^{NS}
KPSW2	70.21	7.47	69.60	8.32	0.52^{NS}
KPSW3	74.62	8.06	72.46	9.7	2.58*
KPSW4	80.08	6.45	75.31	9.9	5.09**

S.D: Standard Deviation

N=No. of patients

*Significant at 0.05 level

**Significant at 0.01 level

Table V. Comparison of VAS Score Between Two Groups

Variables	EXPERIMENTAL GROUP(N=13)		CONTROL GROUP(N=13)		t VALUE
	MEAN	S.D.	MEAN	S.D	
VAS0	5.15	0.86	5.26	0.83	0.25^{NS}
VASW1	5.01	0.91	5.21	0.95	0.04^{NS}
V ASW2	4.58	0.84	4.98	0.79	0.09^{NS}
VASW3	3.52	0.91	4.25	0.71	5.08**
VASW4	1.72	0.80	3.47	0.61	6.23**

S.D: Standard Deviation

N=No. of patients

**Significant at 0.01 level

Conclusion

Statistically significant improvements in pain and function outcome measures in the patients with patellofemoral pain following intervention comprising of backward walking on treadmill indicate its effectiveness when incorporated as a therapeutic regime in these patients and is therefore recommended in the rehabilitation of PFPS patients.

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