Importance of Dynamic Joint Control Training in Postmeniscectomy Knee Rehabilitation

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ABSTRACT

This study was conducted to clarify the importance of the dynamic joint control training, and the role of proprioception, and mechanoreceptors in kinaesthetic awareness (the detection of movement and acceleration) or adjustments, in postmeniscectomy knee joint rehabilitation. Forty postmeniscectomy patients were included in the study, and were divided into two groups at random. The first group underwent standard exercise program (a three-phase rehabilitation program that emphasized progressive resistive exercises), and the second group followed the standard program plus dynamic joint control training. Subjects were tested on the Stabil-Ometer infrared stability platform model 16125IR/PS (Lafayette Instrument Co, Lafayette, IN 47903, U.S.A) after its reliability had been tested. The time on center was calculated for each subject. The mean time on center was 9.25 sec. ± 6.15 sec. for the first group, and 22.6 sec. ± 4.89 sec. for the second group. The differences were significant. This means that dynamic control training had a significant effect upon the restoration of balance in postmeniscectomy patients.

Key words: Knee Rehabilitation, Meniscectomy, Balance, Dynamic, Control, Knee Joint.

INTRODUCTION

The postoperative effects of meniscectomy on the knee joint function was shown to be ranging from adverse predictions that degeneratative arthritis and instability will eventually follow the surgery[15,21] to reports that it is a simple procedure, specially through the use of the arthroscopic technique, allows the patient to return to heavy physical effort without apparent disability[6,18]. Meniscectomy has been reported to cause atrophy and loss of strength, so that the aim of the postmeniscectomy rehabilitation has been to restore strength and function of the involved limb[3,16].

While strength, endurance, and muscular power have received considerable attention in postmeniscectomy rehabilitation, little attention has been directed to restoration of neuromuscular coordination, and balance. Recently, hamstring training to prevent anterior subluxations and quadriceps training to increase structural stiffness of the knee joint during posterior impact against the tibia have been emphasized[9,22]. In addition both muscles have to function quickly and adequately during an unexpected movement or trauma. The mechanoreceptors in and around the knee provide the central nervous system with information about joint position, motion, and loading pattern changes. In turn the central

nervous system stimulates the muscles around the knee to function properly and makes the necessary adjustments[7,17]. The shorter the latency that exists in that neuromuscular reaction, the less the stress to the knee structures. A dynamic joint control training for the postmeniscectomy patients, helps to shorten the latency of neuromuscular reaction[10].

Balance can be described as the ability to maintain the center of gravity of the body over the base of support. Postmeniscectomy patients commonly display balance-related deviations as sway during quiet standing, longer response times to regain balance following externally applied forces[2], and alterations in weight-bearing patterns[4]. A decrease in weight-bearing on the affected side and the decreased ability to shift weight onto the affected side. This decrease in weight-bearing leading to abnormal lateral stance steadiness, is a major cause of falls towards the affected side[1].

Clinical balance assessments consist of gross, qualitative evaluations, giving only subjective impressions for estimating dysfunction.

The stabil-ometer balance platform is able to give objective information about weight-bearing patterns and balance. In order to use the platform as an objective measure of balance in postmeniscectomy patients, the reliability of this system needs to be established. Establishment of the reliability of the platform would provide a valuable tool for investigating the effects of balance training programs.

MATERIALS AND METHODS

Two experimental studies were conducted; the first was to assess the reliability of the balance platform, and the second was to compare the results of two groups of postmeniscectomy patients following different rehabilitation programs.

Subjects:

Twenty normal volunteers (12 male and 8 female) with a mean age of 24.35 years (range 19-32), participated in the first study; and forty postmeniscectomy volunteer patients assigned to two groups at random. The first group (18 males and 2 females) with a mean age of 28.35 years (range 20-40); and the second group (16 males and 4 females) with a mean age of 29.25 years (range 21-42). Subjects were chosen on the following criteria:

1) unilateral postmeniscectomy, left or right, male or female; **2)** no lower limb deformity or past history of any lower limb injury 12 months prior to the study (except for the menisceal injury); **3)** ability to stand for 30 seconds with no assistant device; and **4)** ability to understand and follow verbal instructions.

Instrumentation:

a) Stabil-ometer infrared stability balance platform.
b) Rocker board with two halves of circles situated on the bottom which allows anteroposterior movement.
c) Balancing board atop a section of sphere allowing multidirectional movement.

Procedures:

I) For the reliability assessment of the balance platform:

Testing was conducted in two consecutive days. Day one was used to acquaint the patient with balance platform and the test sequence. On the second day subjects received two tests, each of which lasted 30 seconds, followed by a rest period of 30 seconds.

Subjects step onto the platform so that he/she is facing the control, subject was told to begin balancing when he sees the green test light (located on the top of the control) turn on, and end the test when the green light turns off. The area included as "on-center" was adjusted to 5 degrees on either side of the perpendicular. The total time on-center is displayed on the screen of the control. The reset button is depressed then to clear the display before starting the next test. Data from both tests were recorded for each patient.

II) For the study of the effect of dynamic joint control training on postmeniscectomy patients:

A) Treatment:

Both groups followed a standard three-phase rehabilitation program that emphasized progressive resistive exercises. Patients underwent 3 sessions per week during a three month period of rehabilitation. In addition the second group performed the following during phase three to train the fast twitch fibers of the hamstring and the quadriceps muscles so as to improve the dynamic joint control[8,12]:

1- The patient stood on both legs and made "foot fists" i.e., made attempts to grasp the floor or an object with both feet.
2- The patient sat with the foot of the injured side on a rocker board. The patient tried to control the movement of the board as quickly as possible.
3- The patient sat with both feet on a balancing board. when the therapist moved the board suddenly, the patient tried to stop the board's movement as quickly as possible.
4- The patient stood with foot of the injured side on the balacing board. Patient tried to control its equilibrium against the sudden force given by the therapist.

B) Balance testing:

At the end of the treatment both groups were tested for balance using the same procedures used for the normal subjects in the reliability assessment, the mean of the two tests was calculated for each subject.

Data analysis:

Intraclass correlation coefficients (ICCs) were calculated to describe the degree of intratester agreement for measurements obtained in the reliability study. The advantage of using the ICC in reliability studies is that it calculates the degree of agreement between two or more measurements, and not simply the association between them[13]. An ICC value of 0.90 or greater was considered to be highly reliable, a value between 0.75-0.89 was considered moderately reliable, and a value below 0.75 was considered unreliable[20]. The unpaired t-test was used for comparison between patients two groups, differences were considered significant at $P < .05$.

RESULTS

The results of the reliability study were summarized and presented in table 1. The balancing platform was found to be highly reliable for balance assessment (ICC=0.91).

Table (1): Test retest reliability of the balancing platform:

	Test	Retest
Range		
Minimum	8.00	10.00
Maximum	30.00	30.00
Mean	23.59	23.60
St. deviation	6.08	5.66
St. error	1.27	1.36
ICC	0.91	

Table (2) shows comparison between the two postmeniscectomy groups mean time on-center. The first group received only the three-phase rehabilitation program, mean time on-center was 9.25 ± 6.15 sec. (Range 0-19), and the second group received the three phase rehabilitation program plus the dynamic joint control training, mean time on-center was 22.6 ± 4.89 sec. (Range 11-30). The t-value was -7.60 and the 2-tail probability was 0.00. These values indicate that there was a significant difference in the length of time on-center between the two postmeniscectomy groups (fig. 1).

Table (2): Comparison between the two postmeniscectomy groups time on-center after treatment:

	Group 1	Group 2
Range		
Minimum	0.00	11.00
Maximum	19.00	30.00
Mean	9.25	22.60
St. deviation	6.15	4.89
St. error	1.37	1.09
t- value	-7.60	
2-tail probability	0.00	

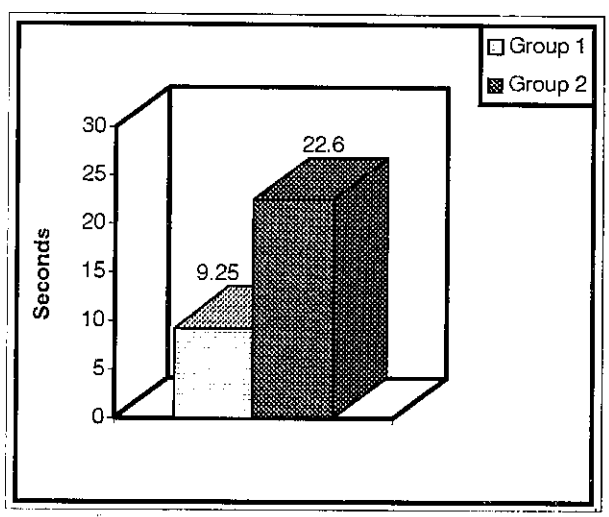

Fig. (1): Mean time on-center for both postmeniscectomy groups after treatment.

The subject population used in this two part study consisted of normal subjects and postmeniscectomy patients, both male and female, of varying ages. The scope of this study did not include obtaining results for the different subgroups of the researched population. The number of subjects in the study were not sufficient to perform such analysis.

The results of the study showed that, for a test-retest of normal subjects, the balacing platform was highly reliable. A greater reliability may well have been obtained had the practice period exceeded one day. Attempts to eliminate tester error were made by using the same tester for all tests, and giving standardized instructions to the subjects.

The mechanoreceptors detect the changes in position and loading of the knee joint and forward it to the central nervous system which reacts accordingly by controlling the tension of the muscles around the knee. The high level of neuromuscular reaction was closely related to high levels of functional ability[5]. Injury to or diseases affecting the joint's soft tissues produce profound impairment of postural and kinesthetic sensations in relation to the affected joint. Instability depends on many factors; muscular coordination, joint geometry, and joint laxity. They are all changed after meniscectomy[15]. Accordingly failure of the affected knee in providing adequate feedback to the central nervous system might contribute to unpredictable giving way and result in weight-bearing patterns change, and finally imbalance[11].

To improve the neuromuscular coordination and reaction time, the dynamic joint control training was used to improve foot function, equilibrium, reaction to sudden movement or force, and quick transference of body weight from one leg to another[8].

To objectively evaluate the effectiveness of the program the stabil-ometer stability platform was proven to be a reliable, objective tool for assessing patients balance and progress[14,19,23]. The dynamic joint control training was proven to be very effective in restoration of balance in postmeniscectomy patients. It is suggested that the program could be used as an integral part of lower limb injuries rehabilitation programs.

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الملخص العربى

أهمية التدريب الديناميكى على التحكم فى المفصل فى تأهيل مفصل الركبه بعد إستئصال الغضروف

يهدف هذا البحث لدراسة تأثير التدريب الديناميكى على التحكم فى المفصل فى زيادة كفاءة مفصل الركبة وإستعادة الاتزان بعد إزالة الغضروف ، وكذلك فى التأكد من درجة الثقة لجهاز قياس الاتزان ، ثم إستخدامه لقياس الفرق فى درجة الاتزان لمجموعتان من المرضى بعد إستئصال الغضروف . تم تأهيل إحدى المجموعات بإستخدام برنامج العلاج القياسى وإتبعت المجموعة الثانية نفس البرنامج بالإضافة إلى تدريبات التحكم الديناميكى فى المفصل . أتبعت كل مجموعة برنامج التدريبات الخاص بها لمدة أثنا عشر أسبوعا بواقع ثلاث جلسات أسبوعيا .

بعد إستكمال البرنامج تم تقييم الاتزان بإستخدام جهاز قياس الاتزان .

أشارت نتائج البحث إلى وجود إرتباط معنوى وثيق بين نتائج إختبار مجموعة من الأصحاء مرتين متتاليتين بإستخدام جهاز الاتزان مما يدل على درجة ثقة عالية فى أداء الجهاز .

كذلك أظهرت النتائج وجود فروق معنويه بين أداء مجموعتى المرضى على جهاز قياس الاتزان مما يدل على التأثير الإيجابى للتدريب الديناميكى على التحكم فى المفصل فى زيادة ثبات وتحسن وظيفة مفصل الركبة وإستعادة الاتزان بعد عملية إستئصال الغضروف .