



ISOKINETIC EXERCISE MACHINE

**HEALTH TECHNOLOGY ASSESSMENT SECTION
MEDICAL DEVELOPMENT DIVISION
MINISTRY OF HEALTH MALAYSIA**

021/09

DISCLAIMER

Technology review is a brief report, prepared on an urgent basis, which draw on restricted reviews from analysis of pertinent literature, on expert opinion and / or regulatory status where appropriate. It has not been externally reviewed. While effort has been made to do so, this document may not fully reflect all scientific research available. Additionally, other relevant scientific findings may have been reported since completion of the review.

Please contact: htamalaysia@moh.gov.my, if you would like further information.

Health Technology Assessment Section,
Medical Development Division
Ministry of Health Malaysia
Level 4, Block E1, Precinct 1
Federal Government Administrative Centre
62590 Putrajaya

Tel: 603 88831246

Fax: 603 8883 1230

Available at the following website: <http://www.moh.gov.my>

Prepared by:

Dr. Izzuna Mudla bt Mohamed Ghazali
Principal Assistant Director
Health Technology Assessment Section
Ministry of Health Malaysia

Dr. Fauziah Ahmad
Final Year
Master of Public Health (Oral Health)
Faculty of Dentistry
University of Malaya

Reviewed by:

Datin Dr. Rugayah bt Bakri
Deputy Director
Health Technology Assessment Section
Ministry of Health Malaysia

DISCLOSURE

The authors of this report have no competing interest in this subject and the preparation of this report is totally funded by the Ministry of Health, Malaysia

EXECUTIVE SUMMARY

Introduction

Isokinetic exercise is a form of exercise that permits maximum muscle contraction throughout the full range of joint movement. An isokinetic machine is a rehabilitative exercise device intended for medical purposes, such as to measure, evaluate and increase the strength of muscles and the range of motion of joints.

This review was requested by a senior physiotherapist from Tuanku Jaafar Hospital, Seremban.

Aims/objectives

To assess the safety, effectiveness, cost effectiveness and organisational impact of isokinetic exercise machine for rehabilitation of musculoskeletal disorders.

Results and conclusion

Isokinetic exercise machine usage may improve muscular strength in healthy adults but not in stroke patients. The evidence also showed that isokinetic exercise machine is a reliable tool for isokinetic muscle performance measurement and able to assess muscle strength more objectively but may not be consistent with manual test. There was insufficient evidence on the safety of isokinetic exercise machine. Moreover this machine is costly.

Recommendation

Isokinetic exercise machine can be used to assess muscular strength objectively and may improve muscular strength in healthy adults. However the high cost and the large area required to install the machine should be taken into consideration before decision to procure the equipment is made, apart from training that may need to be instituted to the users prior operationalizing the machine.

Methods

Literature were searched through electronic databases which included Medline, Cochrane Library, Science Direct and general databases such as Google and Yahoo.

The search strategy used the terms, which were either used singly or in various combinations: “isokinetic exercise machine”, “isokinetic dynamometer”, “isokinetic devices”, “isokinetic machine”, “isokinetic equipments”, “musculoskeletal disorders”, physiotherapy and rehabilitation. The search was limited to articles on human. There was no language limitation in the search.

Systematic reviews, meta-analysis and randomised clinical trials pertaining to effectiveness, safety and cost effectiveness of isokinetic exercise machine were included.

A critical appraisal of all relevant literature was performed using Critical Appraisal Skills Programme (CASP) checklists and the evidence graded according to the US/Canadian Preventive Services Task Force Level of Evidence (2001).

ISOKINETIC EXERCISE MACHINE

1. INTRODUCTION

Isokinetic exercise is a form of exercise that permits maximum muscle contraction throughout the full range of joint movement. An isokinetic machine is a rehabilitative exercise device intended for medical purposes, such as to measure, evaluate and increase the strength of muscles and the range of motion of joints.

Isokinetic exercises may be performed concentrically (muscles shorten during contraction) or eccentrically (muscles lengthen during contraction) as external forces are applied to the limb. These contrasting forms of dynamic resistance exercise allow for application of high muscular loads, and consequently high skeletal loads. When maintained over a sufficient period, these forms of exercise may afford a means of safely and optimally promoting functional and structural adaptations in bone and muscle tissue.¹

It was first introduced in 1950's where Hettinger Dynamometer was the first isometric measurement system used. In 1967, a speed controlled machine, CYBEX 1, the first isokinetic exercise machine was introduced in United States of America. In Europe, CYCOB was introduced in 1976 at Karolinska University, Sweden. Since then isokinetic machines have been used in many countries.

This review was requested by a senior physiotherapist from Tuanku Jaafar Hospital, Seremban.

2. OBJECTIVES

To assess the safety, effectiveness, cost effectiveness and organisational impact of isokinetic exercise machine for rehabilitation of musculoskeletal disorders.

3. TECHNICAL FEATURES



There are two major types of machine available to offer isokinetic exercise;

1. Type 1 - An active dynamometer – in this type of exercise, the speed is controlled whilst resistance is variable according to the amount of force throughout the range of movement.
2. Type 2 – utilizes a change in the moment arm of the selected resistance to coincide with the change in moment arm of

the muscle effort and the change in tension due to muscle length change.

Isokinetic exercise machines or isokinetic dynamometers are mainly used to measure muscular strength in musculoskeletal rehabilitation which aims to restore optimal form of function after injury or surgery. The final stage of rehabilitation aims to return an individual to normal activities via resistance exercises that are usually focused at regaining muscle strength.

Most isokinetic exercise machines are equipped with these components:

- Computer System/Clinical Data System
- Dynamometer
- Attachments to parts of body, such as attachment for ankle, knee, shoulder, elbow, wrist, hip and/or upper body extremity table



4. METHODOLOGY

4.1 SEARCH METHODS

Literature were searched through electronic databases which included Medline, Cochrane Library, Science Direct and general databases such as Google and Yahoo.

The search strategy used the terms, which were either used singly or in various combinations: “isokinetic exercise machine”, “isokinetic dynamometer”, “isokinetic devices”, “isokinetic machine”, “isokinetic equipments”, “musculoskeletal disorders”, physiotherapy and rehabilitation. The search was limited to articles on human. There was no language limitation in the search.

4.2 SELECTION OF STUDIES INCLUDED /EXCLUDED

Systematic reviews, meta-analysis and randomised clinical trials pertaining to effectiveness, safety, and cost effectiveness of isokinetic exercise machine were included. Studies on isokinetic exercise without using the machine were excluded.

A critical appraisal of all relevant literature was performed using Critical Appraisal Skills Programme (CASP) checklists and the evidence graded according to the US/Canadian Preventive Services Task Force Level of Evidence (2001).

Data were extracted and summarized in evidence table as in Appendix 3. The data were not pooled and only qualitative analysis was carried out.

5. RESULTS AND DISCUSSION

There were seven articles on isokinetic exercise machine retrieved. Two of the articles were randomised controlled trials, one article was on cohort study and the other two articles each were on case control and cross sectional studies.

5.1 EFFICACY/EFFECTIVENESS

Nickols Richardson *et al.* compared the effect of high load concentric versus eccentric modalities of isokinetic training on muscular strength and bone mineral in the trained and untrained limbs of young adult women undergoing 5 months of isokinetic resistance training. They found that muscular strength (peak torque) of the trained leg was significantly higher after training in both the concentric and eccentric training groups, and muscular strength gains in the trained legs were significantly greater than in the untrained leg. There was also significant gains in muscular strength of the trained arm found between baseline and post training in both groups.^{1 Level 1} There was significant increase in total body bone mineral content (TB BMC), total proximal femur bone mineral density (TPF BMD) and total body fat free soft tissue mass (TB FFSTM), in both the concentric and eccentric training group from baseline to post training.^{1 Level 1}

Kim *et al.* in a double blind pilot study assessed the effects of isokinetic strength training on walking performance, muscle strength and health related quality of life in survivors of chronic stroke. The results showed that there was a greater improvement in the muscle strength in the experimental group than the in control groups however it was not statistically significant. As for walking performance, the mean level-walking and stair-climbing speeds were higher after the intervention than at baseline. However, there were no group differences in change scores of level-walking and stair-climbing speeds. No significant differences were found in the changes in SF-36 scores between the two groups.^{2 Level 1}

In a prospective cohort study, Balague *et al.* describe the recovery of ankle muscle performance measured by manual and isokinetic muscle testing in 82 patients with severe sciatica for 1 year. Manual and isokinetic tests were performed on foot and ankle flexor as well as extensor muscle at discharge, and during follow up visits at 3, 6 and 12 month respectively. They found that the isokinetic test showed a higher prevalence of muscle

function impairment and slower recovery than the manual test. The study revealed that at the final visit, the isokinetic test showed impaired muscle function recovery from 23% to 32%, in comparison to the manual test which showed almost full recovery. They found that one third of the patient have a muscle performance deficiency, and this deficiency may not be detectable with a manual test. Using manual test, muscle weakness tested consistent with L5 or S1 root lesions was found in 15% of patients ($n=12$) at baseline and in 5% of patients ($n=4$) at discharge. When assessed with isokinetic exercise machine, more than 50% of the patients had measurable isokinetic muscle performance deficit.³ Level II-2 The authors recommended isokinetic testing as a functional tool in patients who engage in physically demanding work or activities to determine their level of function.

Aquino *et al.* assessed the knee flexors and knee extensor muscles using a Cybex 6000 dynamometer among women with primary osteoarthritis undergoing primary unilateral total knee arthroplasty. The results showed significant difference in the maximum flexor torque and the maximum extensor torque in the intervention and control group. The flexion/extension ratio for maximum torque was significantly different between treated side of patients and non-dominant side in controls. There was no significant difference observed between treated side of patients and dominant side of controls for flexion or extension ratio for maximum torque.⁴ Level II-2

Nakano *et al.* used isokinetic dynamometer to evaluate the functional limitation caused by subclavian artery occlusive disease (SAOD) in the upper limbs. They found no difference in comparing all limbs without arterial disease of both groups. Considering that upper limbs without arterial disease have a similar response to exercise, this study compared upper limbs in group 1 (with and without SAOD). Significant differences were found between the groups in relation to number of repetitions ($p<0.001$), total work throughout the test ($p<0.001$), average work per series of 30 repetitions ($p=0.022$), average work per repetition ($p=0.022$), peak torque ($p=0.019$), systolic arterial pressure before the test ($p<0.001$), systolic arterial pressure after the test ($p<0.001$), and the ratio between the systolic pressures ($p<0.001$). For all the parameters, the limbs with SAOD presented significantly lower values than the control limb.⁵ Level II-2 The result support the use of this test to facilitate classification of patient according to their functional impairment.

Keskula *et al.* assessed interrater reliability of isokinetic measures of knee flexion and extension and found that the intraclass correlation coefficients (ICCs) for peak torque ranged from 0.90 to 0.96 and 0.90 to 0.95 for total work. The standard error of measurement (SEM) for peak torque ranged from 8.9 to 13.3 Nm and 11.3 to 16.8 Nm for total work. The results showed that reliable measures of isokinetic muscle performance of knee extension and flexion may be obtained by different operators with varied experience when following a standardized measurement protocol.⁶ Level II-3

Rabita *et al.* compared the kinematic parameters of imposed ankle mobilizations measured during Ashworth (manual) and isokinetic tests. Three kinematic parameters analyzed were initial ankle position, maximal angular velocity and maximal angular acceleration, with plantarflexor reflex responses obtained with each method. There was no significant difference ($p>0.05$) between the clinical test and the isokinetic one on plantarflexion.

However the Ashworth test varied from one clinician to another. They showed that the kinematic parameters of ankle mobilization during Ashworth and isokinetic tests differed considerably, specifically angular acceleration and angular velocity were lower during the isokinetic test. A clonus response was observed in six patients during the Ashworth test but no clonus was observed with the isokinetic dynamometer. The results revealed that isokinetic exercise machines objectively quantify the muscle resistive pattern to stretch in spastic patient, however they cannot be used to simulate the manual test.⁷ Level II-3

5.2 SAFETY

Isokinetic exercise machine is considered as safe since an individual will never meet more resistance than he can handle because the resistance is equal to the force applied.⁸ None of the studies retrieved reported any adverse events related to isokinetic exercise machine usage. However, there were reported adverse event submitted to Food and Drug Administration (FDA), United States such as patella dislocation occurred during the exercise and malfunction of the machine. Certain brand of isokinetic machine such as Biodex System 4 Pro is CE certified.

5.3 COST EFFECTIVENESS

There was no article retrieved on cost effectiveness of isokinetic exercise machine. The cost of each machine is more than RM500,000.00.

5.4 ORGANISATIONAL ASPECT

5.4.1 INFRASTRUCTURE

Isokinetic exercise machines are bulky. The total operating floor spaces required differ from one model to another. For example Cybex 6000 needs about 120 square feet area to be installed (Figure 1) whereas newer models such as Biodex System 4 Pro System 4 Quick Set require 32 square feet. The space requirement aspect therefore needs to be considered when one is planning to procure the isokinetic exercise machine.

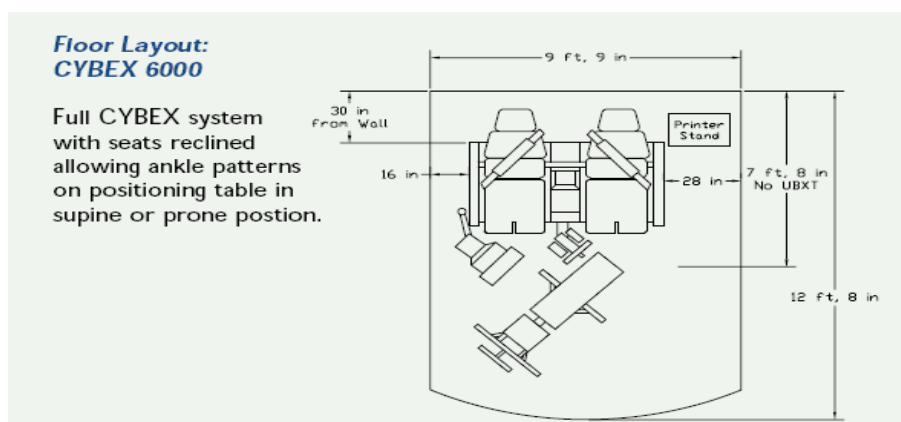


Figure 1. Floor Layout for Cybex 6000

5.4.2 TRAINING

There was no study retrievable on training aspect requirement of operators prior handling the machine.

6. CONCLUSION

Based on the review, isokinetic exercise machine usage may improve muscular strength in healthy adults but not in stroke patients. The evidence showed that isokinetic exercise machine is a reliable tool for isokinetic muscle performance measurement and able to assess muscle strength more objectively, but may not be consistent with manual test. However, there was insufficient evidence on the safety of isokinetic exercise machine. The disadvantages related to its high cost and large space requirement should be forewarned.

7. RECOMMENDATION

Based on the above review, the isokinetic exercise machine can be used to assess muscular strength objectively and may improve muscular strength in healthy adults. However the high cost and the large area required to install the machine should be taken into consideration before decision to procure the equipment is made, apart from training that may need to be instituted to the users prior operationalizing the machine.

8. REFERENCES

1. Nickols- Richardson SM, Miller LE, Wootten DF, *et al.* Concentric and eccentric isokinetic resistance training similarly increases muscular strength, fat free soft tissue mass, and specific bone mineral measurements in young women. *Osteoporos Int* 2007;18:789-796.
2. Kim CM, Eng JJ, MacIntyre DL, *et al.* Effects of Isokinetic Strength Training on Walking in Persons with Stroke: A double-blind controlled pilot study. *Journal of Stroke and Cerebrovascular Diseases* 2001;10(6):265-273.
3. Balague F, Nordin M, Sheikhzadeh A, *et al.* Recovery of impaired muscle function in severe sciatica. *Eur Spine J* 2001;10:242-249.
4. Aquino M de A, Garcez-Leme LE. Isokinetic Dynamometry in Elderly Women Undergoing Total Knee Arthroplasty: A comparative Study. *Clinics* 2006;61(3):215-22.
5. Nakano L, Wolosker N, Rosoki RA, *et al.* Objective Evaluation of Upper Limb Claudication: Use of Isokinetic Dynamometry. *Clinics* 2006;61(3):189-96.
6. Keskula DR, Dowling JS, Davis VL, *et al.* Interrater Reliability of Isokinetic Measures of Knee Flexion and Extension. *Journal of Athletic Training* 1995;30(2):167-170.

7. Rabita G, Dupont L, Thevenon A, *et al.* Differences in kinematic parameters and plantarflexor reflex responses between manual (Ashworth) and isokinetic mobilizations in spasticity assessment. *Clinical Neurophysiology* 2005;116:93-100.
8. Li RCT, Chan KM. The Attainment in the Usage of An isokinetic Programme With the Cybex II Model. *The Journal of the Hong Kong Physiotherapy Association* 1987;9:10-15.