Prescribed Post-Operative Exercise Following Total Hip Replacement Surgery.

by

James McLauchlan
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[redacted]

Dr. R.D. Bell, Supervisor, (School of Physical Education)

[redacted]

Dr. D. Docherty, Departmental Member, (School of Physical Education)

[redacted]

Dr. W. Muir, Outside Member, (Faculty of Education)

[redacted]

Dr R. Backus, External Examiner, (University Health Services)

Supervisor: Dr. Robert D. Bell

ABSTRACT

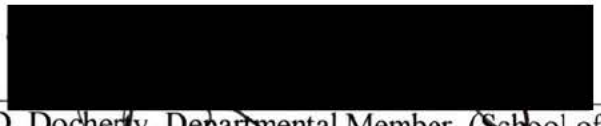
This study investigated the effects of a prescribed post-operative exercise program, as a complement to normal acute physiotherapy, on quality of life, functional capacity, walking ability, strength, and aerobic power following total hip replacement surgery. The participants, 10 men and 13 women, (mean age 66 years), were allocated to an exercise group (n=13), or a control group (n=10). The experimental group took part in supervised cardiovascular and weight training sessions three times per week for eight weeks, commencing an average of 10 weeks after the operation. The control group were not given an exercise program, but were allowed to pursue their normal lifestyles for the eight-week period they were in the study. Participants in both groups were tested at the beginning and end of the eight-week period for quality of life, functional capacity, walking distance, strength of hip muscle groups, and aerobic power. There were no significant differences between the groups in any of the measures at the start of the study period. All 23 subjects completed the program.

After the eight-week program, both groups exhibited significant gains ($p < .05$) in all measures. There were significant differences ($p < .05$) in the degree of improvement between groups in all measures, the exercise group exhibiting superior performance changes.

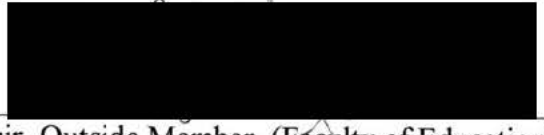
These data suggest that a prescribed post-operative exercise program may improve quality of life, general functional capacity, strength and cardiovascular fitness, well beyond that expected from the normal acute physiotherapy protocol following total hip replacement surgery.

Examiners:

Dr. R.D. Bell, Supervisor, (School of Physical Education)



Dr. D. Docherty, Departmental Member, (School of Physical Education)



Dr. W. Muir, Outside Member, (Faculty of Education)

Dr R. Backus, External Examiner, (University Health Services)

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Acknowledgements

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I acknowledge with gratitude the trust and confidence of the surgeons and the participants in the study. We all broke new ground with this approach to continued functional recovery after total joint replacement, and this has made possible the introduction of a community based exercise rehab program.

I acknowledge and thank the manager Dan Pagely and the staff at Gordon Head Community Recreation Centre for having the vision to take on the rehab program and help support it through the difficult early growth, to where we are today, with great possibilities for the future.

The very nature of the subject has, in part, led to a long drawn out study program and I acknowledge with thanks the continuous support and encouragement of my supervisor Dr Bob Bell, and the faculty and staff of the School of Physical Education.

Prescribed Post-operative Exercise following Total Hip Replacement Surgery

Introduction

Hip disease can cause disabling pain, instability and decreased range of motion in the affected joint (Johnston & Smidt, 1970). These factors often lead to a reduced quality of life and may interfere significantly with the individual's ability to work and to pursue the normal activities of daily living. Early surgical intervention procedures, such as hip fusion, relieved pain and provided a stable hip but often failed to restore range of motion and functional capacity (Johnston & Smidt, 1970). Over the last 30 years total hip replacement has been developed which will normally relieve pain, provide stability, and restore range of motion. The first successful cemented total hip replacements were performed by Sir John Charnley in England in 1962. Today, approximately 400,000 operations are performed annually worldwide (Moller, Goldie, & Jonsson, 1992).

Patients respond to surgery in various ways. Differences in demographic factors such as age, gender, occupation, and previous activity levels, together with physiological factors, such as cardiorespiratory fitness, musculo-skeletal condition, and co-existent disease, can all affect the outcome of total hip replacement. Patients that have been diagnosed for total hip replacement may be less active than other people, and this may contribute to a general degradation of cardiovascular fitness and mobility. Total hip replacement patients who have been habitually inactive are at higher risk of complications from surgery through such factors as obesity, diabetes, poor nutrition and long term medication usage. These factors can have a detrimental effect on the response of the patient to the operation, particularly to anesthetic, and also on the rate of recovery and

return to normal activities of daily living after the operation (Greenfield, Apolone, McNeil, & Cleary, 1993).

Currently, the normal treatment process in the Greater Victoria area involves attendance at one pre-operative education session at the hospital, three to five days of acute post-operative in-patient therapy prior to discharge, a further three to five days of out-patient therapy if required, followed by the option of further out-patient therapy at the hospital, use of the Capital Health Region home visitation program, or attendance at a private clinic. It is estimated that in the Capital Health Region 50% of total hip replacement patients do not take full advantage of outpatient therapy services after the operation, and that less than 20% of patients take part in an extended exercise or activity program to assist with full functional recovery.

Surgeons normally carry out a follow up assessment at three months following the operation. It would clearly be possible for them to determine patients' activity levels at that consultation, and to refer patients to supervised exercise programs or to make recommendations for appropriate home-based exercise regimens. To date, this has not been common practice in Victoria.

Moller et al. (1992) have suggested that "reorganizing the rehabilitation program to provide only initial treatment at the hospital with follow-up care at home after discharge" (p. 94), may have the effect of reducing length of stay in hospital and subsequently, waiting lists for total hip replacement operations. This practice, however, would require careful consideration of the best use of staff resources, particularly with an extensive home visiting program. It may be more efficient and economical to see patients

post-operatively at local community based activity centres. This might also result in increased socialization and mobility of patients through the possible beneficial effects of group cohesion on adherence to exercise programs (Duda, 1991).

There are very few studies that have investigated the effects of appropriate post-operative exercise programs on functional outcomes from total hip replacement. Some studies have reported functional progress after the operation, but these have mainly evaluated the long term outcomes with no post-operative intervention (Roush, 1985). The achievement of longer term functional independence and an active lifestyle may be facilitated by the introduction of specialized post-operative exercise programs to complement acute post-operative physical therapy.

The purpose of this study was to investigate whether a prescribed post-operative exercise program in addition to the usual acute therapy would improve functional capability and quality of life outcomes following total hip replacement surgery.

Subjects

Subjects were volunteers obtained from the 1996/7 patient lists of participating surgeons operating at the Royal Jubilee Hospital in Victoria, British Columbia. The available population base for this study related to a projected annual operating list for 1996/97 of approximately 320 patients. The names of patients in the target age group of 60 to 75 years identified for surgery were supplied by the participating surgeons' offices. Patients were randomly preselected to join the experimental or control group, and were asked to agree to be allocated in accordance with the preselection. A total of 23 subjects, 13 in the experimental group and 10 in the control group, participated in the study.

Subjects volunteering to take part in the study, were required to obtain the approval of their surgeon and/or physician, and were asked to give informed consent. Volunteer subjects from the operating lists who were so functionally limited that they could not complete the baseline tests or could not carry out the exercise program were excluded from the study.

Method

An eight-week experimental/control group study was employed in which subjects in both groups initially underwent baseline testing for quality of life, functional capacity, walking speed, strength of hip muscle groups, and aerobic power. Because of surgical operation scheduling, the subjects were not all available at the same time. The average time after an individual operation that the baseline tests were conducted was ten weeks. The tests were repeated after a further eight weeks. Following baseline testing, the experimental group of subjects took part in supervised cardiovascular and weight training sessions three times per week for eight weeks. A standard exercise session consisted of (1) combined bilateral arm and leg aerobic exercise using a Schwinn cycle ergometer, (2) whole body strength training using variable resistance machines, with due protection of affected joints (Seto & Brewster, 1991), (3) range of motion development and maintenance using a combination of resistance machines and free weights, (4) stretching and flexibility of non symptom limited musculo-skeletal groups, and (5) walking as tolerated to develop normal gait and endurance. The control group were not given an exercise program, but were allowed to pursue their normal lifestyles for the eight-week period they were in the study.

Differing tolerance levels shown by participants in the experimental group to the training regimen were accommodated by using a target heart rate of 70% heart rate reserve and the Borg perceived exertion scale to monitor intensity. Prescribed exercises took into account range-of-motion limitations appropriate to post-operative total hip replacement patients (Maihafer, 1990).

A typical exercise session began with a low-intensity five minute warm-up period on a Schwinn Airdyne cycle ergometer, allowing for a gradual increase in exercise intensity to a comfortable working level equivalent to a Borg level 11-13 or 60 - 80% Heart Rate Reserve. Subjects were coached during the early exercise sessions in the use of perceived exertion and heart rate monitoring. The aerobic training section was gradually built up to a total of 15 minutes on the cycle ergometer, and each session finished with up to 15 minutes on the Concept II rower, including a two minute warm-down.

The strength training section consisted of a range of machine based and free weight exercises and stretches to strengthen the major muscle groups of the body. This was done with due consideration for those specific muscle groups affected by the previously diseased joint and by surgery.

The gait and walking endurance development section built up to a total of six minutes of walking to observe and record mobility limitations and changes. Careful records were maintained of exercise session activity to monitor progress, and to allow individual tailoring of the exercise prescription as required.

The following measures were used to evaluate outcomes from the study:

1. The Schedule for the Evaluation of Individual Quality of Life, (O'Boyle, McGee, Hickey, O'Malley, & Joyce, 1992). The schedule was devised from the technique known as judgement analysis to measure patients' level of functioning in five self nominated facets of life and the relative weight or importance attached to these areas.

2. Harris Hip Scale, (Harris, 1969). The Harris Hip Scale is recognized among orthopaedic surgeons as the gold standard used to assess physical status in patients with total joint replacements (Shields, Enloe, Evans, Smith, & Steckel, 1995)

3. Six-minute walk test, (Guyatt, Sullivan, Thompson, Fallen, Pugsley, Taylor, & Berman, 1985). A six minute timed walk test over a measured 38 metre indoor course was administered and evaluated separately to the gait test contained in the overall Harris hip score. Subjects were asked to cover as much ground as they could in the allotted time, using walking aids as required. A predetermined set of encouraging phrases was delivered to subjects during the walk, such as "you're doing well," "keep up the good work". (Guyatt et al., 1985). The pulse rate was recorded at the end of the six-minute walk test. This test also acted as a warm up for the strength tests. The subject was observed for gait abnormalities during the walk. A five-minute rest was allowed before commencing the muscle strength testing.

4. One repetition maximum (1RM) strength of certain muscle groups, (Fiatarone, Marks, Ryan, Meredith, Lewis, Lipsitz, & Evans, 1990). The dynamic strength of hip abductors (gluteus medius and minimus), adductors (adductor longus group), extensors (gluteus maximus), and flexors (iliopsoas) of the affected leg were measured using a one repetition maximum technique, after Fiatarone et al. (1990), on a universal weight and

pulley system. The one repetition maximum was defined as the highest weight the subject could move one time only through the available range of motion of the respective muscle groups. After familiarization with the equipment and the testing procedure, muscle groups were tested sequentially, adding weight in 1Kg increments, resting 20 seconds between lifts, until the subject could no longer move the weight through the range of motion. A five minute rest was allowed before commencing the aerobic power test.

5. Aerobic power using a Schwinn Airdyne windvane ergometer. (Bostom, Bates, Mazzerella, Block, & Adler, 1987; Nagle, Richie, & Giese, 1984; Telford, Hooper, & Chennels, 1980.) This piece of equipment is calibrated to indicate workload, and allows for accurate cardiovascular testing and training. The aerobic power test was preceded by a three minute low intensity warmup to elevate the heart rate to the individual subject's target zone. This heart rate was calculated using the Karvonen method to establish 70% of the heart rate reserve, corresponding to a perceived exertion on the BORG scale of 11-13. The subjects worked at this level of exertion for five minutes and the total Kcal expended was recorded. The Kcal total measured in this way is (1) representative of the subject's sub-maximal short-term aerobic power, (2) takes pain and disability limitations to maximum effort into account, and (3) is preferred to a maximal test for this type of subject.

Independent sample t-tests were used for between group comparisons pre- and post-test. Paired sample t-tests were used to compare groups on pre- and post-test performance measures. Univariate analysis of covariance was used to adjust for any pre-

test differences between the groups. The level of significance for all comparisons was set at $p < .05$.

A preliminary study was conducted before the main data collection commenced to establish reliability of the measuring techniques to be applied by the researcher. The reliability tests were carried out on previous hip replacement volunteer subjects of similar age to the potential main study subjects, selected following normal informed consent procedures. The test re-test correlation coefficients obtained ranged from .875 to .995.

The study was approved by the University of Victoria Human Research Ethics Committee on 26th May 1995, and by the Greater Victoria Hospital Society Research Review and Ethical Approval Committee on 10th May 1995.

Results

There were no significant differences between the Exercise Group and the Control Group at pre-test on any of the performance measures. There were some variations between the groups that failed to reach significance. These were tested using an analysis of covariance. Both groups exhibited significant improvement from pre- to post-test in all measures, ($p < .05$), (see Tables and Figures 1 to 5).

Results from the analysis of covariance indicated that there were differences in the amount of improvement between the two groups. The experimental group improved significantly more in each measure (< .05). The significance of the F-Ratios were for **Quality of life:** $p<.005$, for **Functional Capacity:** $p<.005$, for **Walking Distance** $p<.001$, for **Muscle Strength:** $p<.001$, and for **Aerobic Power:** $p<.003$. (see Tables and Figures 1 to 5).

Quality of Life: The experimental group improved quality of life scores from 28 to 58 (110%, p = <.001); the control group improved from 28 to 49 (73%, p = <.001). (See Table 1 and Figure 1.)

Table 1. Means (x) and Standard Deviations (sd) of Quality of Life scores for Exercise and Control Groups on Pre and Post-Tests.

GROUP	PRE x (sd)	POST x (sd)	2-tail sig	t-value/df
EXERCISE	27.77 (9.18)	58.46 (8.65)	p<.001*	14.05/12
CONTROL	28.40 (8.15)	49.10 (6.51)	p<.001*	6.69/9

* significantly different at p < .05 level

ANCOVA results:	F-ratio	df	sig. of F
Main effect for group:	10.20	1/20	.005

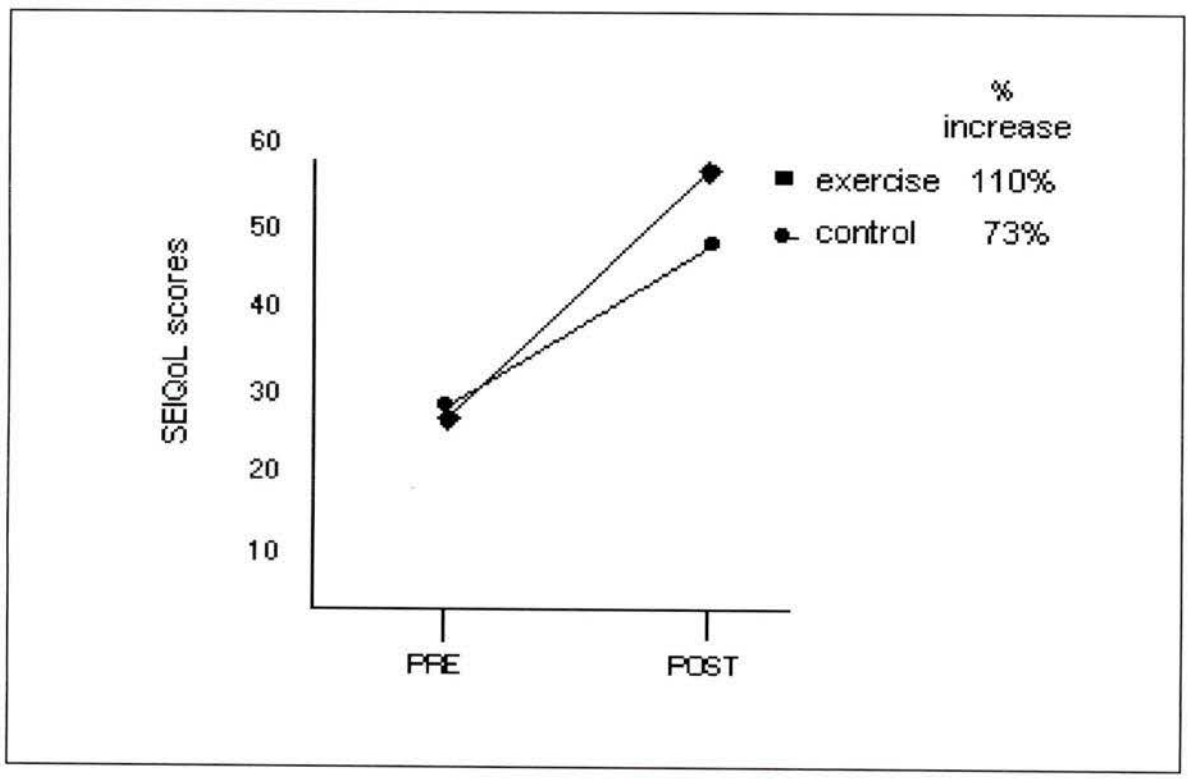

Figure 1. Quality of Life Scores from Pre to Post-Test for Exercise and Control Groups.

Functional Capacity: The experimental group improved Harris Hip Scale scores from 72 to 93 (28%, p = <.001); the control group improved from 65 to 81 (26%, p = <.001). (See Table 2 and Figure 2).

Table 2. Means (x) and Standard Deviations (sd) of Functional Capacity (FC) scores for Exercise and Control Groups on Pre and Post-Tests.

GROUP	PRE x (sd)	POST x (sd)	2-tail sig	t-value/df
EXERCISE	72.46(10.75)	93.00 (7.21)	p<.001*	10.24/12
CONTROL	64.80 (9.37)	81.60 (7.66)	p<.001*	8.50/9

* significantly different at p < .05 level

ANCOVA results:	F-ratio	df	sig. of F
Main effect for group:	9.99	1/20	.005

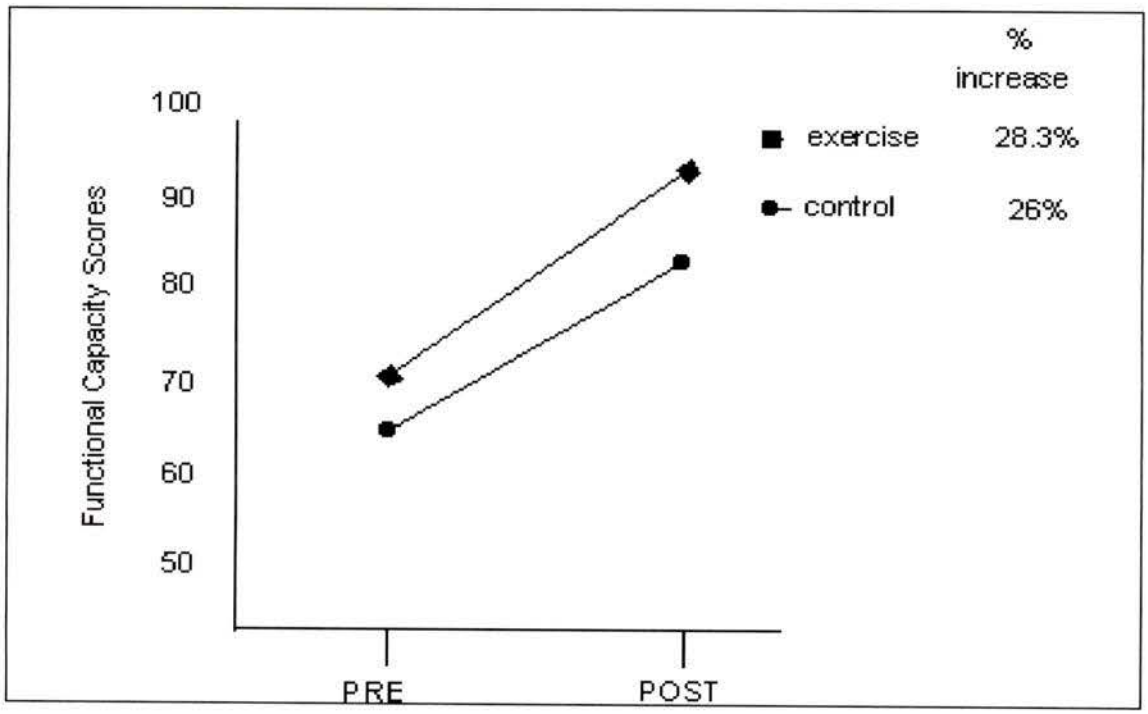

Figure 2. Functional Capacity Scores from Pre to Post-Test for Exercise and Control Groups.

Walking Distance: The experimental group improved from 455 metres to 542 metres (19%, p = <.001); the control group improved from 419 metres to 438 metres (5%, p = .002). (See Table 3 and Figure 3).

Table 3. Means (x) and Standard Deviations (sd) of Walking Distance (WD) scores (metres) for Exercise and Control Groups on Pre and Post-Tests.

GROUP	PRE x (sd)	POST x (sd)	2-tail sig	t-value/df
EXERCISE	455.23 (85.97)	542.23 (102.8)	p<.001*	6.99/12
CONTROL	419.20 (75.87)	438.30 (71.75)	p<.002*	4.37/9

* significantly different at p < .05 level

ANCOVA results:	F-ratio	df	sig. of F
Main effect for group:	18.81	1/20	.000

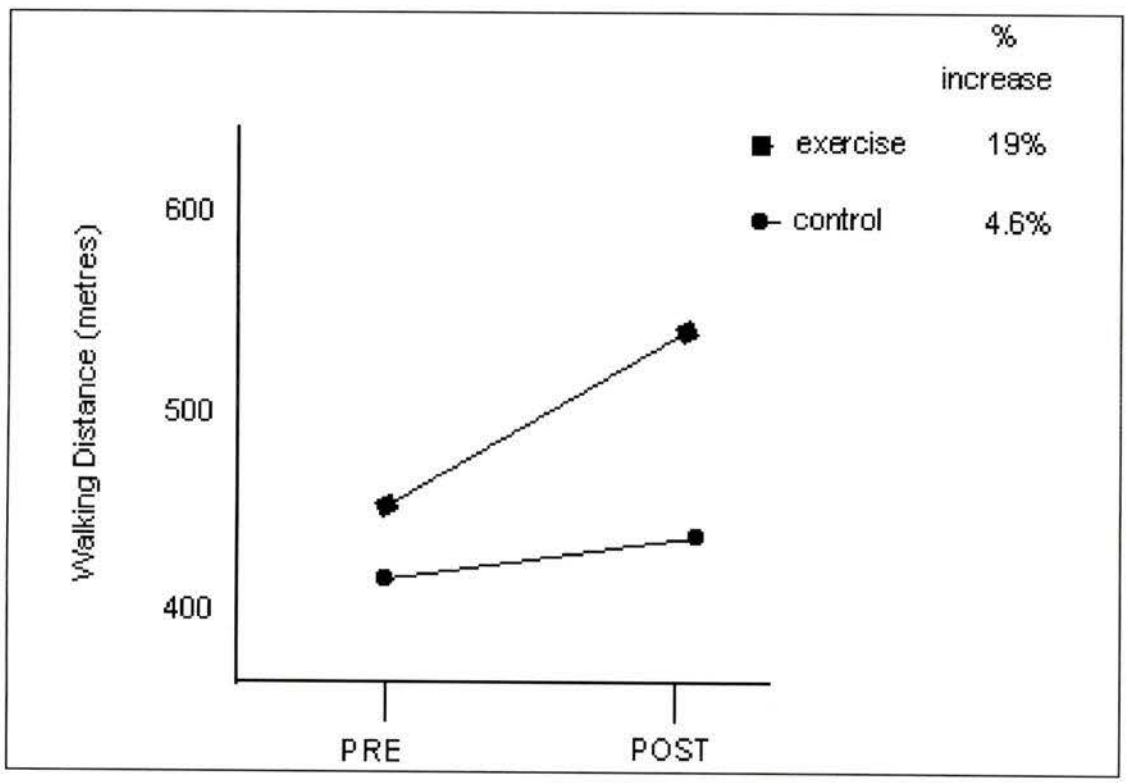

Figure 3. Walking Distance Scores (metres) from Pre to Post-Test for Exercise and Control Groups.

Hip Muscle Strength: The experimental group improved from 26 Kg to 40 Kg (57%, p = <.001); the control group improved from 29Kg to 33Kg (16%, p =.002). (See Table 4 and Figure 4).

Table 4. Means (x) and Standard Deviations (sd) of Hip Strength (Kg) scores for Exercise and Control Groups on Pre and Post-Tests.

GROUP	PRE x (sd)	POST x (sd)	2-tail sig	t-value/df
EXERCISE	25.66 (8.51)	40.31 (10.00)	p<.001*	12.14/12
CONTROL	28.75 (9.44)	33.38 (8.75)	p<.002*	4.21/9

* significantly different at p < .05 level

ANCOVA results:	F-ratio	df	sig. of F
Main effect for group:	32.26	1/20	.000

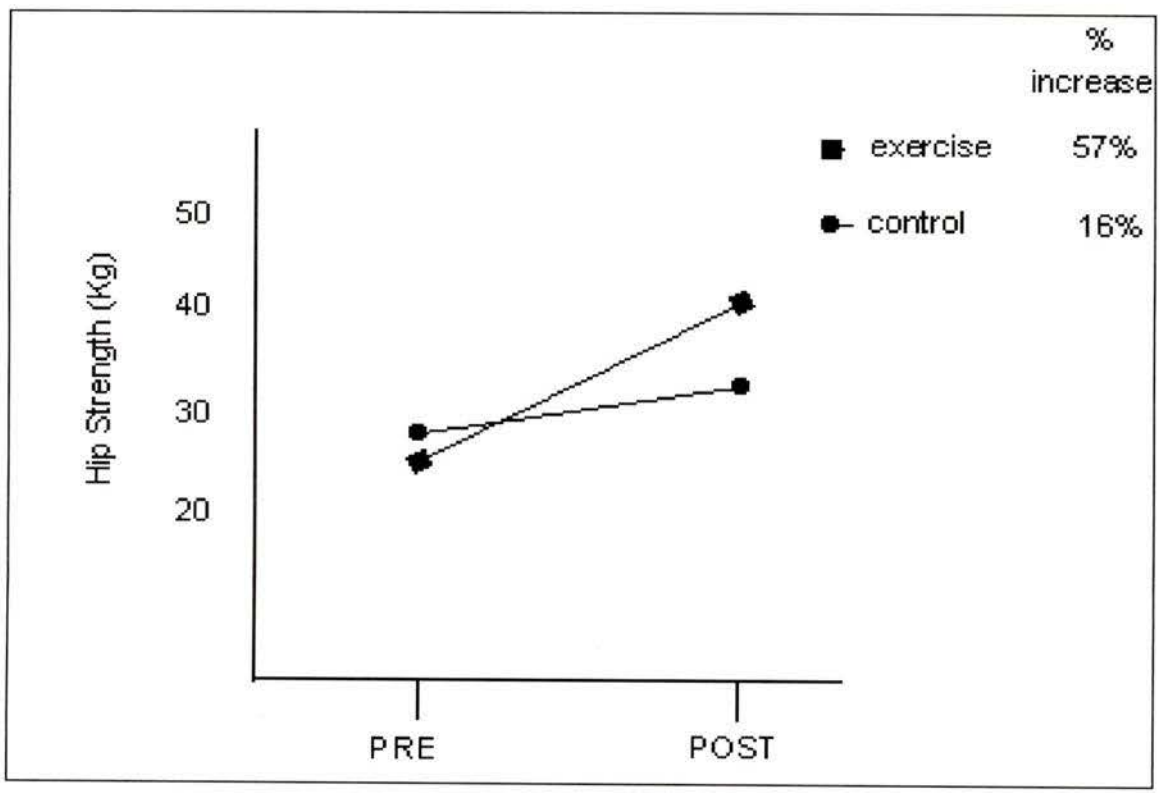

Figure 4. Hip Strength Scores (Kg) from Pre to Post-Test for Exercise and Control Groups.

Aerobic Power: The experimental group improved from 32 Kcal to 44 Kcal (38%, p = <.001); the control group improved from 36 Kcal to 40 Kcal (13%, p = .006). (See Table 5 and Figure 5).

Table 5. Means (x) and Standard Deviations (sd) of Aerobic Power (KCal) scores for Exercise and Control Groups on Pre and Post-Tests.

GROUP	PRE x (sd)	POST x (sd)	2-tail sig	t-value/df
EXERCISE	31.85 (11.13)	43.85 (12.35)	p<.001*	7.49/12
CONTROL	35.70 (10.34)	40.20 (11.67)	p<.006*	3.53/9

* significantly different at p < .05 level

ANCOVA results:	F-ratio	df	sig. of F
Main effect for group:	11.40	1/20	.003

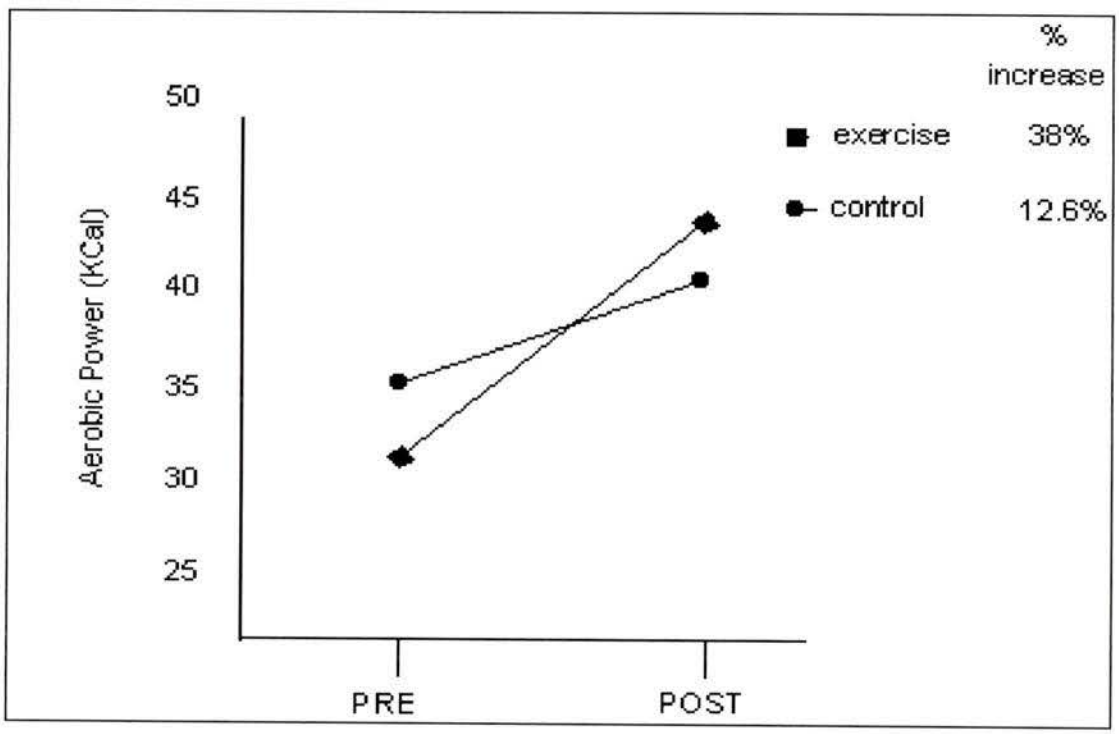

Figure 5. Aerobic Power scores (KCal) from Pre to Post-Test for Exercise and Control Groups.

Discussion

The total hip replacement operation has become more sophisticated since the first procedures were performed more than 35 years ago. Anticipated outcomes from the procedure now include improvements in quality of life, functional capacity, walking ability, strength and aerobic power. This is supported by the results in that both groups showed significant increases in all measures from pre- to post-test.

The 13 subjects in the experimental group attended all exercise sessions and found the experience both enjoyable and beneficial. These participants reported that they felt fitter, were more positive in their attitude to daily living activities, and welcomed the interaction with other people in similar physical circumstances to themselves.

One of the objectives of this study was to demonstrate that total joint replacement recipients could safely continue their post operative functional rehabilitation in community recreation facilities within a few weeks of the operation. This practice could effectively reduce the demand on hospital outpatient facilities. A minimum post-operative time of six weeks was initially set for the baseline testing, to allow participants to attend the outpatient physiotherapy at the hospital. The actual average elapsed time to baseline testing was 10 weeks. The baseline tests were applied cautiously, with due consideration for the post-operative healing process, and therefore may not have been representative of the true muscle strength and cardiovascular capacity of the participants. The results may still be viewed as representative of their practical functional ability in activities of daily living. Several techniques were developed for the study to allow patients to use common standard exercise equipment safely during the critical three month period following their

operation. For example, the Concept II Rower was used within the first three months after the operation with the foot of the operated leg placed on the floor. This limited the range of motion of the operated hip to 90 degrees, but still provided an overall workout for targeted muscle groups. After three months the foot of the operated leg was placed on the footrest of the rower, and range of motion development was allowed beyond 90 degrees. Other resistance training machines which involved the lower extremities were set to limit range of motion to 90 degrees for a similar period.

Bryant et al. (1993) concluded from factor analysis that the three most important variables in outcome assessment following total hip replacement surgery are pain, walking distance and range of hip flexion. The evaluation instruments used in the present study included an assessment of these three variables. The instruments appeared to be effective in detecting performance changes in the experimental and control groups, and provided a mix of quantified objective and subjective data.

Walking distance was assessed using the six minute walk test, as described by Guyatt et al. (1985). At the time of initial testing, both groups were able to ambulate above the speed needed to cross safely at a city crosswalk (0.9 m/sec or 2.025 mph). The exercise group developed more rapidly than the control group in terms of cardiovascular fitness and quality of gait, and were able to dispense with walking aids sooner. The post-test speeds of 1.5 m/sec (3.4 mph) and 1.2 m/sec (2.7 mph) for the exercise and control groups respectively, attest to the effectiveness of the hip replacement procedure and the exercise program.

The methods used to measure and develop strength of the hip musculature were selected after consideration of findings by Hodge, Carlson, Fijan, Kjirste, Burgess, Riley, Mann, and Harris (1989), Krebs, Elbaum, Riley, Hodge, and Mann (1991), and Strickland, Fares, Krebs, Riley, Givens-Heiss, Hodge, and Mann (1992). Important recommendations from these studies included a preference for low rate, light load isotonic exercise, rather than high rate isokinetic, or isometric activity. In the present study, the baseline and post-test strength measures were carried out using the 1RM method (Fiatarone et al 1990). Lightly loaded pulley exercises were utilised to strengthen the hip musculature, with a gradual progressive increase over the period of the exercise program.

The main contributors to hip joint loading through pelvic stability are the abductor muscles, which are important for normal gait. Any loss of strength in the hip musculature, particularly the abductors, can lead to joint dysfunction and gait irregularities. Shih, Du, Lin, and Wu (1994) found that hip flexors showed the slowest recovery rate over the first year, but for the hip musculature as a whole, "without an active exercise program, full recovery may take more than a year. To speed up recovery and prolong the life of the hip joint replacement, long term strengthening exercises for the involved muscles should be encouraged" (p120). The results of the present study tend to support the conclusion by Shih et al that an active exercise program may speed up recovery, but there is little evidence at present to suggest that exercise may prolong the life of the hip joint replacement.

Aerobic power of the participants was evaluated using a sub-maximal exercise test on a Schwinn Airdyne cycle ergometer. This test was preferred to a walking test to elicit

sub-maximal heart rates as it is a non load-bearing whole body exercise, and eliminated the potentially inhibiting effects of acute gait problems and the need to use walking aids. The test was well tolerated by the participants and produced quantified data indicating a steady increase in cardiovascular fitness throughout the exercise period. The exercise group received extra benefit from the eight week training, improving by 38% compared with the control group increase of 13%.

The results of the analysis of covariance indicated significant differences in the degree of improvement for all measures between the experimental (exercise) group and the control (non-exercise) group. These results would suggest that an eight week prescribed exercise program, in addition to normal acute post operative therapy, may be effective in eliciting significant functional improvements for individuals following total hip replacement surgery.

Conclusion

Prescribed post-operative exercise, in addition to normal acute physiotherapy, may improve quality of life, general functional capacity, strength and cardiovascular fitness, over and above benefits expected from the normal therapy protocol following total hip replacement.

It is suggested that longitudinal studies be carried out to determine whether regular prescribed exercise will have the effect of prolonging the life of a total joint replacement.

References

Bostom, A.G., Bates, E., Mazzerella, N., Block, E., & Adler, J. (1987). Ergometer modification for combined arm-leg use by lower extremity amputees in cardiovascular testing and training. Archives of Physical and Medical Rehabilitation, 68, 244-247.

Bryant, M.J., Kernohan, W.G., Nixon, J.R., & Mollan, R.A.B. (1993). A statistical analysis of hip scores. The Journal of Bone and Joint Surgery, 75-B, 705-709.

Duda, J. L. (1991). Motivating older adults for physical activity: It's never too late. Journal of Physical Education Recreation and Dance , 44-48

Fiatarone, M.A., Marks, E.C., Ryan, N.D., Meredith, C.N., Lipsitz, L.A., Evans, W.J. (1990). High intensity strength training in nonagenarians. Journal of the American Medical Association, 263: 3029-34.

Galante, J. (1985). The need for a standardized system for evaluating results of total hip surgery (editorial). The Journal of Bone and Joint Surgery, 67 A (4), 511-512.

Galante, J. (1990). Evaluation of results of total hip replacement (editorial). The Journal of Bone and Joint Surgery, 72-A, 159-160.

Greenfield, S., Apolone, G., McNeil, B.J., & Cleary, P.D. (1993). The importance of co-existent disease in the occurrence of post-operative complications and one-year recovery in patients undergoing total hip replacement. Medical Care, 31 (2), 141-154.

Guyatt, G. H., Sullivan, M. J., Thompson, P. J., Fallen, E. L., Pugsley, S. O., Taylor, D. W., & Berman, L. B. (1985). The 6-minute walk: A new measure of exercise capacity in patients with chronic heart failure. Canadian Medical Association Journal, 132, 919-922.

Harris, W. H. (1969). Traumatic arthritis of the hip after dislocation and acetabular fractures: Treatment by mold arthroplasty, an end-result study using a new method of result evaluation. The Journal of Bone and Joint Surgery, 51 A (4), 737-755.

Hodge, W.A., Carlson, K.L., Fisan, R.S. (1989). Contact pressures from an instrumented hip endoprosthesis. Journal of Bone and Joint Surgery (Am); 71: 1378-86.

Johnston, R.C., & Smidt, G.L. (1970). Hip motion measurements for selected activities of daily living. Clinical Orthopaedics and Related Research, 72, 205-215.

Krebs, D.E., Elbaum, L., Riley, P.O., Hodge, W.A., & Mann, R.W. (1991). Exercise and gait effects on in vivo hip contact pressures. Physical Therapy, 71 (4), 301-309.

Lieberman, J.R., Dorey, F., Shekelle, P. (1996). Differences in patient versus physician evaluation after total hip arthroplasty. The Journal of Bone and Joint Surgery; 78A.6: 835

Maihafer, G. C. (1990). Rehabilitation of total hip replacements and fracture management considerations. In J. L. Echternach (Ed.), Physical Therapy of the Hip. New York: Churchill Livingstone.

Moller,G., Goldie, I., & Jonsson, E. (1992). Hospital care versus home care for rehabilitation. International Journal of Technology Assessment in Health Care, 8 (1), 93-101.

Nagle, F. J., Richie, J. P., & Giese, M. D. (1984). VO_{2max} responses in separate and combined arm and leg air-braked ergometer exercise. Medicine and Science in Sport and Exercise, 16 (6), 563-566

O'Boyle, C.A., McGee, H., Hickey, A., O'Malley K., Joyce, C.R.B. (1992). Individual quality of life in patients undergoing hip replacement. The Lancet; 339, 1088-91

Roush, S.E. (1985). Patient-perceived functional outcomes associated with elective hip and knee arthroplasties. Physical Therapy, 65 (10), 1496-1500.

Seto, J. L., & Brewster, C. E. (1991). Musculoskeletal conditioning of the older athlete. Clinics in Sports Medicine, 10 (2), 401-429.

Shih, C.H., Du, Y.K., Lin, Y.H., & Wu, C.C. (1994). Muscular recovery around the hip joint after total hip arthroplasty. Clinical Orthopaedics and Related Research, 302, 115-120.

Shields, R.K., Enloe, L.J., Evans, R.E., Smith, K.B., Steckel, S.D. (1995). Reliability, validity, and responsiveness of functional tests in patients with total joint replacement. Physical Therapy; 75 (3), 169-179.

Strickland, E.M., Fares, M., Krebs, D.E., Riley, P.O., Givens-Heiss, D.L., Hodge, W.A., & Mann, R.W. (1992). In vivo acetabular contact pressures during rehabilitation, part 1: Acute phase. Physical Therapy, 72 (10), 691-699.

Telford, R. D., Hooper, L. A., & Chennels, M. H. D. (1980). Calibration and comparison of air-braked and mechanically-braked bicycle ergometers. Australian Journal of Sports Medicine, 12, 41-46.

APPENDIX A

Introduction

Introduction

The management of patients with hip disease has, in the past, been a major problem in orthopaedics. Hip disease can cause disabling pain, instability and decreased range of motion (ROM) in the affected joint (Johnston & Smidt, 1970). These factors often lead to a reduced quality of life and may interfere significantly with the individual's ability to work or to pursue the normal activities of daily living (ADL). Early surgical intervention procedures, such as hip fusion, relieved pain and provided a stable hip but often failed to restore ROM and functional capacity (Johnston & Smidt, 1970).

During the last 30 years total hip replacement (THR) has been developed, which will normally relieve pain, provide stability, and restore ROM. The first successful cemented total hip replacements were performed by Sir John Charnley in England in 1962. Today, approximately 400,000 operations are performed annually worldwide (Moller, Goldie, and Jonsson, 1992). The Greater Victoria Hospitals are currently budgeted to perform approximately 320 THR operations annually.

Patients respond to surgery in various ways. Differences in demographic factors such as age, gender, occupation, and previous activity levels, together with physiological factors, such as cardiorespiratory fitness, musculo-skeletal condition, and co-existent disease, can all affect the outcome of THR.

Patients that have been diagnosed for THR may be less active than other people, even though they may have only one joint affected by disease. This can lead to a general degradation of cardiovascular fitness and mobility. THR patients who have been habitually inactive are at higher risk of complications from THR surgery through such

factors as obesity, diabetes, poor nutrition and long term medication usage. These factors may have a detrimental effect on the response of the patient to the operation, particularly to anesthetic, and also on the rate of recovery and return to normal ADL after the operation (Greenfield, Apolone, McNeil, & Cleary, 1993).

Currently, the normal treatment process in the Greater Victoria area involves attendance at one pre-operative education session at the hospital, three to five days of acute post-operative in-patient therapy prior to discharge, a further three to five days of out-patient therapy if required, followed by the option of further out-patient therapy at the hospital, use of the Capital Health Region (CHR) home visitation program, or attendance at a private clinic. It has been estimated that in the CHR 50% of post-THR patients do not take advantage of outpatient therapy services, and less than 20% of patients take part in an exercise or activity program to assist with full functional recovery. Surgeons normally carry out a follow up assessment at three months after the operation. It would clearly be possible for them to determine patients' activity levels at that consultation, and to refer patients to supervised programs or to make recommendations for appropriate home-based exercise regimens.

Moller et al. (1992) have suggested that "reorganizing the rehabilitation program to provide only initial treatment at the hospital with follow-up care at home after discharge" (p. 94), may have the effect of reducing length of stay in hospital and waiting lists for operations. However, this requires careful consideration of the best use of staff resources, particularly with an extensive home visiting program. It may be more efficient and economical to see patients post-operatively at local community based activity centres.

This might also result in increased socialization and mobility of THR patients through the possible beneficial effects of group cohesion on adherence to exercise programs (Duda, 1991).

There are very few studies that have investigated the effects of appropriate pre- or post-operative exercise programs on functional outcomes from THR. Some studies report functional progress after THR, but these have mainly evaluated the long term outcomes with no further intervention (Roush, 1985). The achievement of longer term functional independence and an active lifestyle may be facilitated by the introduction of specialized post-operative exercise programs, to complement acute post-operative physical therapy. The purpose of this study, therefore, was to investigate whether a prescribed exercise program in addition to the usual acute therapy would improve functional and quality of life outcomes following total hip replacement surgery

APPENDIX B

Statement of the problem

Purpose of the study

Research Question

Significance of the study

Delimitations

Limitations

Statement of the problem

The problem, as indicated by enquiry at local hospitals in Greater Victoria, is that there are no known specialized post-operative exercise programs that could assist with longer term recovery and rehabilitation after the acute post-operative out-patient therapy phase. The absence of such programs may be leading to delayed and incomplete functional recovery, to low self esteem in THR patients, and to increased longer term demand on health services for rehabilitation therapy and pharmacological interventions.

Purpose of the Study

The purpose of the study was to investigate the effects of a prescribed post-operative exercise program in addition to normal acute physical therapy, on cardiovascular fitness, functional capacity, and quality of life after THR surgery.

Research Question

Does organized appropriate physical exercise in addition to acute therapy after surgery for THR have any effect on a patient's quality of life, and the speed and completeness of functional recovery after the operation?

Hypothesis

The hypothesis to be tested was that patients undergoing THR surgery who follow a prescribed eight-week exercise program in addition to the current normal post-operative treatment would perform better on a set of outcome measures compared to a control group who received only the current normal post-operative treatment.

For this study, a positive result would be inferred from any significant differences in the outcome measures between the experimental and control groups. A positive result may infer that THR patients may (a) enjoy better quality of life after the operation, (b) become re-integrated into the community more quickly, and (c) be less dependent upon the Greater Victoria health services.

Significance of the study

There are at present (August 1997) no known specialized post-operative exercise programs in the GVHS district for THR patients. A significantly improved performance on outcome measures between experimental and control groups could infer reduced long term demand on health services, and related cost reductions, in addition to benefits to patients' quality of life. This study was intended to show the potential benefits of suitable post-operative exercise programs, and to provide positive information for health administrators upon which to base a strategy for maximizing recovery rates of THR surgery patients in the community.

A review of the orthopaedic and physical therapy literature did not reveal the existence in other Canadian provinces of exercise programs similar to that utilised for this study. The results could, therefore, make a useful contribution to the literature and exercise programming knowledge base in Canada and perhaps other countries.

Delimitations

In an attempt to control as many variables as possible the following delimitations were applied:

1. subjects with severe pain limitations and/or uncontrolled co-existent disease were excluded from the study.
2. subject selection was limited to the patient lists of five surgeons in GVHS to control variables related to initial diagnosis, surgical approach, and patient management.

3. participating surgeons were all operating at the same hospital. This was to help control variables related to education programs, acute therapy, and functional status on discharge.

Limitations

Potential limitations of the study include:

1. generalizability reduced by subject selection criteria
2. availability of sufficient subjects over the time allotted for the study to give sufficient statistical power to the results.
3. the extent of adherence to the prescribed exercise program may have been limited by pain variability amongst subjects.

APPENDIX C

Review of the Literature

Etiology and Incidence of Hip Disease

Total Hip Replacement Surgery

Anticipated Outcomes from Total Hip Replacement Surgery

Actual Outcomes, Potential Confounding Variables

Quality of Functional Recovery

Functional Evaluation in Hip Disease and Joint Replacement

Practical Test Limitations for Post-operative Functional Capacity Evaluation

Practical Tests for Post-op Evaluation in a Comparative Research Study

Exercise Rehabilitation after Total Hip Replacement

Benefits of Exercise Programs before and after Joint Replacement Surgery

Review of the Literature

Etiology and Incidence of Hip Disease

Referring to primary reasons for total hip replacement (THR), Charnley (1972) found in a long term study of THR outcomes that "osteoarthritis was the diagnosis in 70% of subjects and rheumatoid arthritis 25.5%. The residue of 4.5% comprised conditions such as complications of fractured neck of femur, ankylosing spondylitis and Paget's disease of bone" (p.61)

Degenerative arthritis of the hip is a relatively common problem affecting some 10% of the population of North America (National Health Interview Survey). Hip disease can cause disabling pain, instability and decreased range of motion in the affected joint (Johnston & Smidt, 1970). These factors often lead to a reduced quality of life, and may interfere significantly with the individual's ability to work or to pursue normal activities of daily living (ADL).

The cause of degenerative arthritis is varied. The primary category, osteoarthritis, "is a common cause of disability in the elderly, and arthroplasty of the hip accounts for a significant proportion of elective orthopaedic surgery in the United Kingdom (McNicol, McHardy & Chalmers, 1976). Osteoarthritis is characterized clinically by pain, limitation of motion, and deformity. Dunajcik (1989) pointed out that "in many cases osteoarthritis has caused degeneration of the hip joint. In others, the joint has been damaged by rheumatoid or traumatic arthritis, chronic synovitis, congenital hip dysplasia, bone tumour, or aseptic necrosis of the hip" (p. 62). The progression of hip disease is slow, and the

decision to operate is often put off until later in life, leading to a preponderance of elderly people among total joint recipients. Aging can lead to physiological changes in joint and disc cartilage, synovial fluid viscosity, and collagen fibres with resulting decrements in movement qualities of numerous joints (Bell & Hoshizaki, 1981). These degradations may affect the response to surgery, and functional outcomes

Total Hip Replacement Surgery (THR)

In general, primary or secondary degenerative arthritis of the hip is treated initially by conservative measures (Jordan, 1990). This approach will frequently alleviate symptoms and avoid or delay surgical intervention. For conservative management of hip disease to be effective, education of the patient is required to develop an understanding of how best to maintain the integrity of hip function through appropriate exercise, reduction of inflammation, and protection of the joint from stresses of the activities of daily living.

Hip surgery is an elective procedure that is intended to alleviate the symptoms of arthritis by relieving pain, improving function, range of motion, and ambulatory capacity, and to enable the patient to achieve a more normal lifestyle (Jordan, 1990). Roush (1985) points out that "total hip replacement is a widely used orthopaedic technique to relieve pain, increase mobility, and improve function in patients with debilitating arthritis of weight bearing joints" (p.1496). THR surgery is now a common procedure performed in many acute care hospitals, approximately 400,000 operations being performed annually worldwide (Moller et al, 1992).

Jordan (1990) described THR as follows: "A total joint prosthesis as it is known today is made up of an acetabular and a femoral component. Most acetabular components are a combination of a metal shell with an ultra-high-molecular-weight polyethylene articulating inner surface. The femoral component has a chrome-cobalt head and a stem frequently made of titanium alloy. The chrome-cobalt head has superior wear for the articulating surface, and the titanium alloy stem is excellent for stress transfer. The acetabular cups and femoral stems come in a variety of sizes to better match the patient's own bony anatomy". (p74).

There have been many advances in recent years in technology of design and surface finish of total hip prosthetic components. There are now options for fixation between cemented, cementless and hybrid methods. Various surgical methods have been developed which use posterior, transtrocherantic, or anterolateral approaches to the joint. There are advantages and disadvantages associated with each technique (Frndak et al., 1993).

Anticipated Outcomes from Total Hip Replacement Surgery

The majority of THR surgical outcomes are uncomplicated. Serious post-operative complications of THR surgery can occur including hypotension, coma, neuropathy, pulmonary embolism, septicemia, shock, myocardial infarction, congestive heart failure, cerebro-vascular accident (stroke) and renal failure (Maihafer, 1990). These complications, as well as minor complications such as urinary infections and wound infections can create discomfort, prolong the stay in hospital and have a detrimental effect on post-operative recovery.

Patients respond to surgery in various ways. Differences in demographic factors such as age, gender, occupation, and previous activity levels, together with physiological factors, such as cardiorespiratory fitness, musculo-skeletal condition, and co-existent disease, can all affect the outcome of total hip replacement (Roush, 1985). Patients that have been diagnosed for total hip replacement may be less active than other people, and this may contribute to a general degradation of cardiovascular fitness and mobility. These factors can have a detrimental effect on the response of the patient to the operation, particularly to anesthetic, and also on the rate of recovery and return to normal activities of daily living after the operation (Greenfield et al., 1993).

Actual Outcomes, Potential Confounding Variables

In a study of twenty elderly women with unilateral osteoarthritis of the hip, McNicol et al. (1980) tested all subjects for walking speed and oxygen consumption before and after THR surgery. They observed "a significant increase in maximal walking speed, particularly among the more disabled patients, with the major gain occurring by three months and a further slight increase by six months." McNicol et al. further observed economies of oxygen consumption while walking, and increased power output in stair climbing after the operation.

Co-existent disease.

The presence of chronic disease conditions in addition to the primary reason for THR can affect outcomes and conceal the real benefits of the operation. A patient with co-existent disease may not have a successful outcome to THR compared with other patients who have the same primary disease, but no additional complications.

The importance of co-existent disease as a factor affecting outcomes from THR was investigated by Greenfield et al. (1993) in a one-year health related quality of life study involving 356 patients hospitalized for a THR. They found that "the presence and amount of co-existent disease were significant predictors of post-operative complications" (p. 141). Pre-operative impairment was measured in ten functional areas: circulation, respiration, neurological, mental, urinary, fecal, feeding, vision, hearing, and speech. These factors were used to create a physical impairment scale for ranking subjects.

Greenfield et al. excluded patients "if the operation was a revision of a previous procedure, if patients had a diagnosis of rheumatoid arthritis or Paget's disease ... or were transplant patients" (p. 142). The probability of a serious complication seems to increase with increasing comorbidity levels. Comparisons of outcomes from THR and rehabilitation may not be valid if baseline co-existent disease is not controlled for in research design.

Pre-operative and post-operative variables.

Many of the primary reasons for THR can affect other parts of the body as well as the operated hip. The medical and activity history of the patient can clearly have an effect on THR outcome.

The validity of prospective comparative studies is better protected if subjects can be matched for recognized variables. Bias may be introduced in many areas of the research, as suggested by Gross (1988) "including the factors that affect the selection of patients for the study, the selection of the operative procedure to be performed, and the identification and control of all possible variables" (p. 1365). However, it is not always

possible, and not necessary to control for every potential confounding variable or bias. In many cases, an appropriate multivariate analysis technique can provide the necessary distinctions between interaction effects of variables.

The external validity and generalizability of a study conducted in this area, particularly with regard to rehabilitation exercise programming, may well depend on matching of subjects, operating protocols and acute therapy procedures. In addition, the evaluation instruments used to carry out pre- and post-op patient assessments, and the training and inter-rating of the observers, are crucial to the value of the study as a general contribution to the literature.

Patients do not all receive the same procedural treatment from initial diagnosis to final recovery. Hospital districts have different ways of providing pre-operative education, and it is not normal procedure to arrange pre-operative exercise therapy for patients scheduled for total hip replacement surgery. There is usually more than one surgeon performing operations in a given hospital, and not all surgeons use the same operative technique. Post-operative in-patient treatments vary, as do times of discharge from hospital and follow-up physiotherapy for outpatient rehabilitation.

Operating surgeon and methodology.

There are many reports in the orthopaedic literature of clinical studies which investigated and compared various surgical methodologies employed in THR by different surgeons. Choosing the most reliable surgical approach is a difficult decision (Horwitz et al., 1993). Horwitz et al.. also noted that "there are three major decisions facing the orthopedist before implanting a prosthetic hip. The surgeon must choose both an implant

and a mode of fixation (i.e. cement versus cementless). The surgeon must also select a surgical approach" (p. 160).

The main observation is that surgeons tend to use the approach they are trained in and familiar with, and surgeons often favour one form of treatment more than another (Gross et al., 1988). It is not the purpose of this paper to analyze or compare surgical methods. However, it is clear from reports of clinical studies in the literature that different methodologies may variously affect the outcomes of THR surgery.

Horwitz et al. (1993) pointed out that "there is a difference of opinion among orthopedic surgeons regarding the best surgical approach for THR. Today, the most commonly performed approaches to THA include the transtrocherantic lateral approach (Charnley), the muscle splitting lateral approach (Hardinge), and the posterior approach (Moore, Gibson)" (p. 154).

Other variables related to operation methodology include the duration of the surgery, whether autologous blood had been collected and re-infused, the type of anaesthetic, and any complications arising during surgery.

Patient demographics.

The specific factors to be considered under this category that have a potential effect on THR outcome include gender, age, marital status, employment status, educational level, and ethnic origin. Greenfield et al.. (1993) found that at one-year post-op follow up, ADL scores "were significantly related to gender, marital status, education, and race indicating that female, not married, less educated and non white patients tended to have poorer functional outcomes" (p. 149).

Roush (1985) found that gender was shown to be a significant variable in terms of functional outcome, women achieving significantly higher post-operative function scores than men. It was however recognized in this study that different body weights may have been a critical factor, the men tending to be physically larger than the women and perhaps therefore stressing the prosthetic components more.

Pre-operative education program.

In THR pre-op education programs the opportunity is presented to prepare patients for what is an extremely invasive procedure. If patients are to make the best of their new hip they should be adequately prepared prior to the event. The effective evaluation of outcomes requires that every patient scheduled for an operation should attend the pre-op education program, but participation in these programs is normally optional. Financial constraints in some hospital districts restrict the contact with patients before the operation and reduce potential effectiveness of programs. In the Greater Victoria district patients are scheduled for their operation about two months before the event. Education sessions are scheduled before the operation, patients usually attend only one session. The sessions are led by a Physiotherapist and an Occupational Therapist. There are no organized exercise sessions in the period leading up to the operation. There are few reports of patient pre-op education programs published in the literature and in general they seem to be locally formulated and implemented.

Post-operative in-patient therapy.

The duration of hospital stays after the operation varies between districts, partly due to financial constraints, but also because of improved surgical technology and

immediate post-operative care. Liang et al. (1987) pointed out that post-operative "physical therapy (PT) is considered an important component in the rehabilitation of patients undergoing THR, despite the fact that some institutions doing hip replacements claim excellent results with little or no post-operative PT" (p. 276). In their retrospective study of steadily reducing therapy services over a period of four years, Liang et al. found that despite large differences in PT received by groups in the sampled periods, there were no major differences in length of stay between the groups. They also found "no major differences between the groups, compared to similar hospitals, in functional status at discharge, or numbers of surgical complications" (p. 276). It was apparent, however, that even at the reduced levels of PT, the hospital in the Liang et al. study was still providing at least one hour of PT per day, and this could be the minimum necessary to guarantee successful recovery.

Following surgery, it is usual for patients to be weight bearing from the first post-operative day, although limitations are imposed on some movements such as adduction, rotation and flexion of the operated joint. Patients are usually transferred from acute care to a rehab ward after approximately four days, and may be discharged between five and seven days (GVHS). Maihafer (1990) reported that "patients who receive rehabilitation from a skilled professional achieve greater independence and control over their lives in a shorter time than those patients who are left to their own devices post-operatively" (p. 77). Unfortunately, health care administrators tend to measure outcomes not only in terms of health related quality of life (HRQoL) attained but also in terms of cost.

Roush (1985) suggested that outcomes may have been affected by the "attitudinal and social differences between the sexes...leading to the men "toughing out" their pain for longer before seeking medical help, consequently allowing more deformity and damage to occur before surgery" (p.1499). In the Roush (1985) study, subjects that had been stratified above and below the age of 62 years did not show significant differences in functional outcomes related to surgery, but this was not conclusive as varying pre- and post-operative activity levels between younger and older patient groups would influence prosthesis longevity comparisons. Psychosocial factors may affect functional gains after THR, and it is clearly necessary to take account of these physical and social gender differences.

It is seen, therefore, that the success of THR is dependent on many more parameters than simply the prosthesis or surgical approach used (Rorabeck et al., 1994). The management of patients undergoing THR surgery and subsequent functional rehabilitation can be complicated by many different factors.

Quality of Functional Recovery

Functional status on discharge.

It has been reported that the increasing costs of hospitalization create pressure to decrease the length of stay for patients. This shortens the time allowed for therapists to help patients reach the functional criteria for discharge (Erickson & Perkins, 1993). Functional independence depends on a number of factors and hospitals have varying

criteria for discharge after the acute recovery phase. Greater Victoria hospitals include the following factors among the criteria normally required for discharge:

1. Medically stable (condition under control),
2. Pain controlled by analgesics and/or by non pharmacological means,
3. Can walk with or without aids as required by the home situation,
4. Able to transfer from bed, chair, toilet, car, with or without assistive devices or assistance,
5. Family support and equipment in place as required,
6. Referral to community support agencies as required (e.g. meals on wheels, outpatient physio, home nursing),
7. Have obtained physicians order for discharge.

Roush (1985) has indicated that "Artificial joint recipients need to commit themselves to a life style compatible with the intrinsic capabilities of the prosthetic components. To maximize prosthesis longevity and minimize subsequent medical intervention...realistic and understandable expectations of surgery outcomes need to be known and defined in terms that are understandable and relevant to the patient" (p. 1496). This suggests that an effective patient education is also a critical part of the discharge criteria.

Functional Evaluation in Hip Disease and Joint Replacement

An important aspect of THR development is the evaluation of actual performance, success or failure of an operative procedure or a prosthetic device (Galante, 1990).

Measures of outcome are critical in the evaluation of the results of total hip replacement. Accurate outcome evaluation can be confounded by the variables involved in the diagnosis, operation and rehabilitation procedures in THR. There continues to be disagreement in the literature over which evaluation instrument is the most accurate, valid and reliable. It is clear that a validated, uniform, method of evaluating the results is desirable, in a way that is meaningful both to the practitioner and to the patient. The measurements should be specific, reproducible and, if possible, defined by a properly weighted score (Galante, 1990).

Physical therapists and orthopaedic practitioners frequently equate the health status of their patients with joint disease to the level of impairment of function of the joint in question (Jette & Downing, 1994). These biomechanical variables, although providing objective measurements at the level of joint dysfunction, may not be directly related to the patient's overall behaviour outside of the clinical setting. The measures of success of the operation can therefore vary subjectively depending upon the needs of the individual concerned.

Numerous instruments have been developed to assess the diseased hip before and after THR and to evaluate the results of operations on the hip. Johanson et al. (1992) noted that "a number of scoring systems have been developed since the 1960's that include categories or domains of pain, walking and gait, function, range of motion, and muscle strength. The results have usually been reported as excellent, good, fair, or poor, depending on the total score" (p. 587). Bryant et al. (1993) note that "the measured outcome of hip arthroplasty depends upon the hip score used to measure that outcome"

(p. 708), and found large differences between scores that used descriptive terms, and better correlations between those using numerical scores to report outcomes.

There is little evidence in the orthopaedic and physical therapy literature that previous medical or activity history is taken into account in status or outcome evaluation. The most frequently used evaluation instrument, the Harris Hip Scale, does measure some ADL capability but not coexistent disease or previous overall activity levels. For example, it is conceivable that two patients with the same Harris Hip Scale score could have radically different health related quality of life. Another approach is adopted by the MOS 36-item survey scale, also known as the Rand 36-Item Health Survey (Ware & Sherbourne, 1992), which takes into account general health status but is not disease specific.

Pain is a subjective factor, and evaluation methods are difficult to validate. Liang et al. (1990) studied and compared five health status questionnaires in a longitudinal evaluation of orthopaedic surgery. Rorabeck et al. (1994) used six evaluation instruments in a comparative study of cemented and cementless THR operations. Bryant et al. (1993) identified 19 different methods of calculating a hip score, and compared 13 methods of scoring in the post-operative assessment of 47 patients. Their results were found to be inconsistent, often giving varying outcomes with the same patients. Bryant et al. (1993) concluded that "for outcome assessment only three variables need to be recorded: pain, walking distance and range of hip flexion. The combination of these three measures into a single hip score is misleading" (p. 705). From factor analysis, these appeared to be the essential variables for measurement, and it was recommended that they should be recorded

separately. Scales which combine these measures into a single score often differ in the way the scores are weighted, and according to Bryant et al. (1993) are "arbitrary and without scientific foundation". The Harris Hip Scale is favoured by many practitioners, although it does combine the three measures mentioned above into a single score. This scale is recommended for use by the GVHS orthopaedic section because it is commonly used, familiar and not too complicated.

It is recognised within the health profession that total health is a composite of physical functioning and mental and social well being, and that the achievement of an acceptable quality of life (QoL) depends upon maximising these factors as far as possible. Attempts to measure QoL often impose an external value system on patients by use of standardised instrument formats, based on evidence derived from group data. "Instruments designed in this way may be reliable, but whether they are relevant to individual patients is unclear. A valid measure of QoL should quantify the level of functioning of each individual in those areas of life that he or she believes to be the most important" (O'Boyle et al.., 1992).

Practical Test Limitations for Post-operative Functional Capacity Evaluation

Appropriately designed post-operative testing can provide quantifiable and repeatable measures of functional capacity. Simple non invasive tests such as walking, stair climbing, and activities of daily living can provide information which can confirm a clinical assessment. (McNicol et al.,1976). In order to obtain comparative functional

capacity data in THR patients the evaluation techniques should include some form of maximal or sub-maximal testing within the limits of post-operative safety.

Acute post-operative management of THR recipients is designed to prevent loosening of the prosthesis and the consequent longevity of the components. The management protocol includes avoidance of positions that cause dislocations of the hip, "namely, flexion beyond 90 degrees, internal rotation beyond 0 degrees, and adduction beyond 0 degrees". (Jordan, 1990). This is to allow the fibrous capsule around the joint to heal, which usually takes three to four months. Patients with cemented THR can bear weight sooner than those with uncemented THR, as it takes at least six weeks for the bone to grow into the micro-porous surface of the components of the uncemented hip. (Jordan,1990). It is normal to allow a further six weeks for the ingrown bone to become more mature. It is, therefore, not advisable to commence functional capacity testing or vigorous exercise training for patients with uncemented THR within three months after the operation.

Practical Tests for Post-op Evaluation in a Comparative Research Study

In accordance with the findings of Bryant et al. (1993), a practical test battery for post-operative functional capacity should include measures of pain, walking distance or speed, and range of hip flexion. The Harris Hip Scale (Harris, 1969), is recognized among orthopaedic surgeons as the gold standard used to assess physical status in patients with total joint replacements (Shields et al..,1995). This scale includes assessment of pain, walking ability and range of motion in flexion, and is easy to apply.

A six minute timed walk, (Guyatt et al.., 1985), over a measured indoor course is an appropriate test and can be evaluated separately to the gait test contained in the overall Harris hip score. Subjects are asked to cover as much ground as they can in the allotted time, using walking aids as required. Some researchers have found differences between indoor walking speed and outdoor walking speed, but comparison is valid if all subjects walk in the same environment under the same conditions. (Oberg, Karznia & Oberg, 1993). Guyatt et al. (1985) report that "walking tests are simple, inexpensive and safe. They clearly correspond more closely to the demands of everyday activities than cycle ergometer testing, or treadmill exercise testing which can be intimidating to the unpracticed user. In addition, evidence to date suggests that the results of the walking test are highly reproducible" (p.920)

The role of the major hip musculature during gait and other activities of daily living is crucial in terms of stability and mobility. The abductors stabilize the pelvis during stance. The adductors assist in both limb acceleration and deceleration as well as control of the swing in the frontal plane. The extensors appear to control hip and pelvic flexion. The flexors act in the late stance and early swing as the hip reverses its motion from extension into flexion. (Oatis, 1990). It is therefore important to evaluate the strength and functional efficiency of these muscle groups after invasive surgery.

The dynamic strength of hip abductors (gluteus medius and minimus), adductors (adductor longus group), extensors (gluteus maximus), and flexors (iliopsoas) of the affected leg can be measured using a one repetition maximum technique, after Fiatarone et al. (1990), on a universal weight and pulley system. The one repetition maximum is

defined as the highest weight the subject can move one time only through the available range of motion of the respective muscle groups. After familiarization with the equipment and the testing procedure, muscle groups are tested sequentially, adding weight in 1Kg increments, resting 20 seconds between lifts, until the subject can no longer move the weight through the range of motion.

Aerobic power is a contributing factor to endurance in activities of daily living and a convenient method of evaluating aerobic power in subjects that may have functional limitations in one extremity is provided by the Schwinn Airdyne ergometer. (Bostom et al., 1987; Nagle et al ., 1984; Telford et al.., 1980.) This piece of equipment is calibrated to indicate workload, and allows for accurate cardiovascular testing and training. An aerobic power test is preceded by a three minute low intensity warmup to elevate the heart rate to the individual subject's target heart rate zone. This heart rate is calculated using the Karvonen method to establish 70% of the heart rate reserve, corresponding to a perceived exertion on the BORG scale of 11-13. The subjects work at this level of exertion for a suitable period and the total Kcal expended is recorded. The Kcal total measured in this way is (1) representative of the subject's sub-maximal short-term aerobic power, (2) takes pain and disability limitations to maximum effort into account, and (3) is preferred to a maximal test for this type of subject

Exercise Rehabilitation after THR

Reports of prescribed post-operative exercise programs are scarce in the literature. Johnsson, Melander & Onnerfalt (1988) investigated the effects of organized

physiotherapy starting two months after total hip replacement. Their findings "implied that late organized physiotherapy after an uncomplicated THR does not lead to any major functional improvement" (p.45). The exercise regimen was, however, not very challenging and not very frequent, averaging twelve 45 min sessions over a three month period. Subjects were said to have performed the exercises at home "approximately daily" but this evidence was anecdotal. The study found no significant differences between the experimental and control groups in improvement of passive hip motion, or hip or knee muscle strength of the operated limb.

Early rehabilitation programs as prescribed by hospital physiotherapy departments include specific exercises, education in activities of daily living, and gradual introduction of weight bearing. These programs and protocols for acute postoperative rehabilitation are often developed under the direct guidance and supervision of the orthopaedic surgeon. For this study, the ongoing exercise routines and range of motion limitations were prescribed and implemented with the assistance of the participating orthopaedic surgeons in Victoria.

Methods used to measure and develop strength of the hip musculature have been investigated by Hodge et al. (1989), Krebs et al. (1991), and Strickland et al. (1992). These studies found that isometric exercise could produce contact pressures within the hip joint close to those recorded for normal walking, i.e. up to three times the body weight during the stance phase of walking (Shih et al., 1994). Strickland et al. pointed out that "some isometric exercises commonly used in the acute post-operative phase as preparation for gait activities may produce higher femoro-acetabular contact pressures than those

produced by weight shifting and sit-to-stand functional tasks" (p699). Important recommendations from these studies included a preference for low rate, light load isotonic exercise, rather than high rate isokinetic, or isometric activity. Lightly loaded pulley exercises can be utilised to strengthen the hip musculature, with a gradual progressive increase over the period of the exercise program.

Any loss of strength in the hip musculature, particularly the abductors, can lead to joint dysfunction and gait irregularities. Shih et al. (1994) found that hip flexors showed the slowest recovery rate over the first year, but for the hip musculature as a whole, "without an active exercise program, full recovery may take more than a year. To speed up recovery and prolong the life of the hip joint replacement, long term strengthening exercises for the involved muscles should be encouraged" (p120).

Berman et al. (1991) noted that "although arthroplasty has been studied extensively, objective muscle testing has not been reported (p.106). Isokinetic testing correlates well with gait analysis. Patients with a nearly balanced quadriceps to hamstring ratio walk with a more symmetrical gait pattern. Normal function of the hip requires coordinated reciprocal interactions of several muscle groups.

Post-operative out-patient rehabilitation.

In order to recover fully, patients need to receive education so as to fully understand the reasons for the design of their program, and to participate actively in the functional exercise routines. Hospital patient education programs can vary in form and content, and staffing and financial constraints can create further differences in the approach to out patient rehabilitation. Prolonged inactivity and bed rest at the acute

postoperative stage can cause joint contractures, muscle weakness, and bone demineralization, and exercise is seen as an important part of the ongoing rehabilitation process (Dunajcik, 1989).

The main goals of a successful rehabilitation program for THR patients have been identified as 1) pain free motion of the joint, 2) independent symmetrical ambulation, and 3) functional independence in ADL's (Maihafer, 1990). The improvements from the pre-operative to the post-operative functional status that are now possible are maximized when the rehab program takes a holistic approach to the patient. Some hospitals are now taking a multi-disciplinary team approach to rehabilitation, and this comprehensive case management of patients has resulted in improved functional outcomes (Erickson & Perkins, 1994). Longer term functional independence and achievement of an active lifestyle may also require the introduction of specialized exercise programs beyond the present short term post-operative physical therapy approach. Moller et al., (1992) suggested that "reorganizing the rehabilitation program to provide only initial treatment at the hospital with follow up care at home after discharge" (p. 94), may have the effect of reducing waiting lists for operations. This would, however, need careful consideration of the best use of staff resources. It may be seen as more efficient and economical to see patients at community based rehabilitation clinics. This might also result in increased socialization and mobility of THR patients through the known beneficial effects of group cohesion on adherence to exercise programs.

Family support.

In the Moller et al. (1992) study, "the availability of family support at home appeared to predict early discharge more reliably than other factors such as age and medical condition" (p. 100). A capable and supportive family environment, with the time and resources to provide medium to long term care and encouragement, would clearly be an advantage in terms of rehabilitation. Family support, however, varies between individuals, and this strengthens the need for the total case management approach previously mentioned.

Benefits of Exercise Programs before and after Joint Replacement Surgery

Physical inactivity has been associated with increased risk for developing any number of chronic degenerative conditions, including arthritis, the symptoms of which are often seen in persons presenting for THR. It has been shown that approximately 75% of the total population may have activity levels below that required to maintain healthy levels of cardiovascular fitness, body mass index (BMI) and joint mobility (Fitness Canada, 1990). It is common for patients that have been diagnosed for THR to be less active than other people, even though they may have only one joint affected by disease. This may lead to a general degradation of cardiovascular fitness and biomechanical mobility. These factors can have a detrimental effect on the patient's response to the operation, particularly to anesthetic, and also on the rate of recovery and return to normal ADL's after the operation.

It is beneficial to reduce the stress on the diseased hip joint pre-operatively in order to alleviate symptoms as far as possible, and to avoid excessive bed rest or use of a wheelchair. Inactivity can lead to weakened musculature, atrophy, joint contractures and osteoporosis. Stress in the joint can be reduced through unloading the hip by appropriate muscle strengthening exercises, which can also assist with post-operative recovery. (Jordan, 1990).

There are very few studies that have investigated the effects of appropriate pre- or post-operative exercise programs on functional outcomes from total hip replacement. Some studies have reported functional progress after the operation, but these have mainly evaluated the long term outcomes with no post-operative intervention (Roush,1985). The achievement of longer term functional independence and an active lifestyle may be facilitated by the introduction of specialized pre- and post-operative exercise programs to complement acute post-operative physical therapy.

The quality of life for individuals receiving total joint replacements is largely dependent upon their ability to function well in normal activities of daily living. Reduced levels of activity before and after hip surgery can lead to a deterioration in both exercise capacity and physical condition, which together may lead to a reduced ability to live independently (Henderson et al., 1992).

Since the progression of hip disease is slow, and surgeons are often reluctant to operate on younger patients, the decision to operate is often put off until later in life. In older patients, aging has already started to produce a decline in muscle strength, and type II fiber atrophy in skeletal muscle is common in sedentary individuals (Fiatarone et al.,

1990). These factors act to produce a patient population with a high percentage of individuals experiencing the combined effects of (a) aging, (2) inactivity, and (3) post operative trauma. These functional defects and their consequences are an important public health issue (Henderson et al., 1992).

The beneficial effects of regular exercise and strength training as a way of reversing some of the age-related decline has been demonstrated (Fiatarone et al., 1990; Hopp, 1993; Ike, Lampman & Castor, 1989). It is well known that the adverse effects of inactivity can normally be minimised through exercise. Theoretically, it should be possible to address all three of the above factors with an appropriate graduated exercise therapy regimen that takes account of age, previous activity levels, postoperative tissue healing requirements and joint range of motion limitations.

REFERENCES

Altman, R.D., & Dean, D. (1989). Pain in osteoarthritis. Seminars in Arthritis and Rheumatism, 18 (4), supp 2. 1-3.

Anderson, R.A. (1981). Stretching. Slough, G.B: Hollen Street Press

Arborelius, M.M., Carlsson, A.S., & Nilsson, B.E. (1976). Oxygen intake and walking speed before after total hip replacement. Clinical Orthopaedics and Related Research, 121, 113-115.

Barber, T.C., & Healy,W.L. (1993). The hospital cost of total hip arthroplasty. The Journal of Bone and Joint Surgery, 75-A (3) 321-325.

Bell, R.D., & Hoshizaki, T.B. (1981). Relationships of age and sex with range of motion of seventeen joint actions in humans. Canadian Journal of Applied Sports Science, 6 (4), 202-206.

Berman, A.T., Bosacco, & S.J., Israelite, C. (1991). Evaluation of total knee arthroplasty using isokinetic testing. Clinical Orthopaedics and Related Research, 271, 106-113.

Blair, S.N., Brill, P.A., & Barlow, C.E. (1994). Physical activity and disease prevention. In H.A.Quinney, L. Gauvin, & A.E.T.Wall (Eds.). Toward active living: Proceedings of the International Conference on Physical Activity, Fitness, and Health, Toronto, Ontario (pp 25-31). Champaign Ill: Human Kinetics.

Bohannon, R. W., & Andrews, A. W. (1989). Accuracy of spring and strain gauge hand-held dynamometers. Journal of Orthopaedic and Sports Physical Therapy, 323-325.

Bostom, A. G., Bates, E., Mazzerella, N., Block, E., & Adler, J. (1987). Ergometer modification for combined arm-leg use by lower extremity amputees in cardiovascular testing and training. Archives of Physical and Medical Rehabilitation, 68, 244-247.

Bryant, M.J., Kernohan, W.G., Nixon, J.R., & Mollan, R.A.B. (1993). A statistical analysis of hip scores. The Journal of Bone and Joint Surgery, 75-B, 705-709.

Cahalan, T.D., Johnson, M.E., Liu, S., & Chao, E.Y.S. (1989). Quantitative measurements of hip strength in different age groups. Clinical Orthopaedics and Related Research, 246, 136-145.

Charnley, J. (1972). The long-term results of low-friction arthroplasty of the hip performed as a primary intervention. The Journal of Bone and Joint Surgery, 54 B (1), 61-76.

D'Aubigne, R.M., & Postel, M. (1954). Functional results of hip arthroplasty with acrylic prosthesis. The Journal of Bone and Joint Surgery, 36 A (3), 451-475.

Dickinson, W.H., Duwelius, P.J., & Colville, M.R. (1993). Muscle strength testing following surgery for acetabular fractures. Journal of Orthopaedic Trauma, 7, (1), 39-46.

Duda, J. L. (1991). Motivating older adults for physical activity: It's never too late. Journal of Physical Education Recreation and Dance, 44-48

Dunajcik, L.M. (1989). The hip: When the joint must be replaced. Registered Nurse, April, 62-71.

Echternach, J. L., (1990). Evaluation of the hip. In J. L. Echternach (Ed.), Physical therapy of the hip. New York: Churchill Livingstone.

Erickson,B., & Perkins, M. (1994). Interdisciplinary team approach in the rehabilitation of hip and knee arthroplasties. The American Journal of Occupational Therapy, 48 (5), 439-441.

Evans, R. W., (1991). Quality of life. Lancet, 338, 636

Fenstermaker, K. L., Plowman, S. A., & Looney, M. A. (1992). Validation of the Rockport Fitness Walking Test in females 65 years and older. Research Quarterly for Exercise and Sport, 63 (3), 322-327.

Frndak, P.A., Mallory, T.H., & Lombardi, A.V. (1993). Translateral surgical approach to the hip: The abductor muscle "split". Clinical Orthopaedics and Related Research, 295, 135-141.

Galante, J. (1985). The need for a standardized system for evaluating results of total hip surgery (editorial). The Journal of Bone and Joint Surgery, 67 A (4), 511-512.

Galante, J. (1990). Evaluation of results of total hip replacement (editorial). The Journal of Bone and Joint Surgery, 72-A, 159-160.

Givens-Heiss, D.L., Krebs, D.E., Riley, P.O., Strickland, E.M., Fares, M., Hodge, W.A., & Mann, R. (1992). In vivo acetabular contact pressures during rehabilitation, Part II: Postacute phase. Physical Therapy, 72, 700-710.

Greenfield, S., Apolone, G., McNeil, B.J., & Cleary, P.D. (1993). The importance of co-existent disease in the occurrence of post-operative complications and one-year recovery in patients undergoing total hip replacement. Medical Care, 31 (2), 141-154.

Gross, M. (1988). A critique of methodologies used in clinical studies of hip joint arthroplasty published in the English-language orthopaedic literature. The Journal of Bone and Joint Surgery, 70 A (9), 1364-1371.

Guyatt, G. H., Sullivan, M. J., Thompson, P. J., Fallen, E. L., Pugsley, S. O., Taylor, D. W., & Berman, L. B. (1985). The 6-minute walk: A new measure of exercise capacity in patients with chronic heart failure. Canadian Medical Association Journal, 132, 919-922.

Harris, W. H. (1969). Traumatic arthritis of the hip after dislocation and acetabular fractures: Treatment by mold arthroplasty, an end-result study using a new method of result evaluation. The Journal of Bone and Joint Surgery, 51 A (4), 737-755.

Hattori, T., Yamazaki, S., Honjo, H., Miki, S., Hori, K., Sawai, K., Furukawa, R., & Niwa, S. (1983). Gait analysis after total hip replacement for osteoarthritis. In H.Matsui, & K.Koboyashi (Eds.), Biomechanics VIII - Proceedings of the Eighth International Congress of Biomechanics (1981) pp.503-509. Champaign Ill: Human Kinetics.

Henderson, S.A., Finlay, O.E., Murphy, N., Boreham, C., Mollan, R.A.B., Gilmore, D.H., & Beringer, T.R.O. (1992). Benefits of an exercise class for elderly women following hip surgery. The Ulster Medical Journal, 61 (2), 144-150.

Hislop, H. J., & Montgomery, J. (1995). Muscle Testing: Techniques of manual examination. (6th ed.) Toronto: Saunders Co.

Hodge, W.A., Carlson, K.L., Fijan, R.S., Kjirste, L., Burgess, R.G., Riley, P.O., Harris, W.H., & Mann, R.W. (1989). Contact pressures from an instrumented hip endoprosthesis. Journal of Bone and Joint Surgery (Am); 71: 1378-86.

Horwitz, B.R., Rockowitz, N.L., Goll, S.R., Booth, R.E., Balderston, R.A., Rothman, R.H., & Cohn, J.C. (1993). A prospective randomized comparison of two surgical approaches to total hip arthroplasty. Clinical Orthopaedics and Related Research, 291, 154-163.

Howell, D. C. (1989). Fundamental statistics for the behavioural sciences. (2nd ed.). Boston: PWS-Kent.

Izquierdo, R.J., & Northmore-Ball, M.D. (1994). Long-term results of revision hip arthroplasty: Survival analysis with special reference to the femoral component. The Journal of Bone and Joint Surgery, 76 B (1), 34-39.

Jaramillo, J., Worrell, T.W., & Ingersoll, C.D. (1994). Hip isometric strength following knee surgery. Journal of Orthopaedic and Sports Physical Therapy, 20 (3), 160-165.

Jette, A.M. (1993). Using health-related quality of life measures in physical therapy outcomes research. Physical Therapy, 73 (8), 528-537.

Jette, D.U., & Downing, J. (1994). Health status of individuals entering a cardiac rehabilitation program as measured by the medical outcomes study 36-item short-form survey (SF-36). Physical Therapy, 74, (6), 521-527.

Johanson, N.A., Charlson, M.E., Szatrowski, T.P., & Ranawat, C.S. (1992). A self-administered hip-rating questionnaire for the assessment of outcome after total hip replacement. The Journal of Bone and Joint Surgery, 74 A (4), 587-597.

Johnsson, R., Melander, A., & Onnerfalt, R. (1988). Physiotherapy after total hip replacement for primary arthrosis. Scandinavian Journal of Rehabilitation Medicine, 20, 43-45.

Johnston, R.C., Fitzgerald, R.H., Harris, W.H., Poss, R., Muller, M.E. & Sledge., C.B. (1990). Clinical and radiographic evaluation of total hip replacement. The Journal of Bone and Joint Surgery, 72-A, 161-168.

Johnston, R.C., & Smidt, G.L. (1970). Hip motion measurements for selected activities of daily living. Clinical Orthopaedics and Related Research, 72, 205-215.

Jordan, L.R. (1990). Medical and surgical management of the arthritic hip. In J. L. Echternach (Ed.), Physical therapy of the hip. New York: Churchill Livingstone.

Kerr, K.M., White, J.A., Mollan, R.A.B., & Baird, H.E. (1991). Rising from a chair: A review of the literature. Physiotherapy, 77, (1), 15-19.

Kilgus, D.J., Dorey, F.J., Finerman, G.A.M., & Amstutz, H.C. (1991). Patient activity, sports participation, and impact loading on the durability of cemented total hip replacements. Clinical Orthopaedics and Related Research, 269, 25-31.

Kramer, J. F., Vaz, M. D., & Vandervoort, A. A. (1991). Reliability of isometric hip abductor torques during examiner- and belt-resisted tests. Journal of Gerontology, 46 (2), M47-M51.

Krebs, D.E., Elbaum, L., Riley, P.O., Hodge, W.A., & Mann, R.W. (1991). Exercise and gait effects on in vivo hip contact pressures. Physical Therapy, 71 (4), 301-309.

Laupacis, A., Bourne, R., Rorabeck, C., Feeny, D., Wong, C., Tugwell, P., Leslie, K., & Bullas, R. (1993). The effect of total hip replacement on the health-related quality of life. The Journal of Bone and Joint Surgery, 75 A (11), 1619-1626.

Liang, M.H., Cullen, K.E., Larson, M.G., Schwartz, J.A., Robb-Nicholson, C., Fossel, A.H., Roberge, N., & Poss, R. (1987). Effects of reducing physical therapy services on outcomes in total joint arthroplasty. Medical Care, 25 (4), 276-285.

Liang, M.H., Fossel, A.H., & Larson, M.G. (1990). Comparisons of five health status instruments for orthopaedic evaluation. Medical Care, 28 (7), 632-642.

Lieberman, J.R., Dorey, F., Shekelle, P. (1996). Differences in patient versus physician evaluation after total hip arthroplasty. The Journal of Bone and Joint Surgery; 78A.6: 835.

Long, W.T., Dorr, L.D., Healy, B., & Perry, J. (1993). Functional recovery of noncemented total hip arthroplasty. Clinical Orthopaedics and Related Research, 288, 73-77.

MacNicol, M.F., McHardy, R., & Chalmers. (1980). Exercise testing before and after hip arthroplasty. The Journal of Bone and Joint Surgery, 62-B (3), 326-331.

Maihafer, G. C. (1990). Rehabilitation of total hip replacements and fracture management considerations. In J. L. Echternach (Ed.), Physical Therapy of the Hip. New York: Churchill Livingstone.

McHorney,C. A., Ware, J. E., Rogers, W., Raczek, A. E., & Lu, J. F. R. (1992). The validity and relative precision of MOS short- and long-form health status scales and Dartmouth COOP charts. Medical Care, 30 (5), MS253-MS265.

McHorney,C. A., Ware, J. E., & Raczek, A. E. (1993). The MOS 36-item short-form health survey (SF36); II. psychometric and clinical tests of validity in measuring physical and mental health constructs. Medical Care, 31 (3), 247-263.

Menard, M.R., & Hoens, A.M. (1994). Objective evaluation of functional capacity: Medical, occupational and legal settings. Journal of Orthopaedic and Sports Physical Therapy, 19 (5), 249-260.

Moller,G., Goldie, I., & Jonsson, E. (1992). Hospital care versus home care for rehabilitation. International Journal of Technology Assessment in Health Care, 8 (1), 93-101.

Molzahn, A. E. (1991). Quality of life after organ transplantation. Journal of Advanced Nursing, 16, 1042-1047.

Montgomery, L.C., Douglass, L.W., & Deuster, P.A. (1989). Reliability of an isokinetic test of muscle strength and endurance. Journal of Orthopaedics and Sports Physical Therapy, Feb, 315-322.

Murray, M.P., Brewer, B.J., & Zuege, R.C. (1972). Kinesiologic measurements of functional performance before and after McKee-Farrar total hip replacement. The Journal of Bone and Joint Surgery, 54-A (2), 237-256.

Murray, M.P., Gore, D.R., Brewer, B.J., Zuege, R.C., & Gardner, G.M. (1976). Comparison of functional performance after McKee-Farrar, Charnley, and Muller total hip replacement. Clinical Orthopaedics and Related Research, 121, 33-43.

Murray, M.P., & Sepic, S.B. (1968). Maximum isometric torque of hip abductor and adductor muscles. Physical Therapy, 48 (12), 1327-1335.

Nagle, F. J., Richie, J. P., & Giese, M. D. (1984). VO_{2max} responses in separate and combined arm and leg air-braked ergometer exercise. Medicine and Science in Sport and Exercise, 16 (6), 563-566

Oatis, C.A., (1990). Role of the hip in posture and gait. In J. L. Echternach (Ed.), Physical Therapy of the Hip. New York: Churchill Livingstone.

Oberg, T., Karsznia, A., & Oberg, K. (1993). Basic gait parameters: Reference data for normal subjects, 10-79 years of age. Journal of Rehabilitation Research and Development, 30 (2), 210-233.

Perrin, T., Dorr, L.D., Perry, J., Gronley, J., & Hull, D.B. (1985). Functional evaluation of total hip arthroplasty with five- to ten-year follow-up evaluation. Clinical Orthopaedics and Related Research, 195, 252-260.

Pugh, L.G.C.E. (1973). The oxygen intake and energy cost of walking before and after unilateral hip replacement, with some observations on the use of crutches. The Journal of Bone and Joint Surgery, 55-B (4), 742-745.

Rorabeck, C.H., Bourne, R.B., Laupacis, A., Feeny, D., Wong, C., Tugwell, P., Leslie, K., & Bullas, R. (1994). A double-blind study of 250 cases comparing cemented with cementless total hip arthroplasty: Cost-effectiveness and its impact on health-related quality of life. Clinical Orthopaedics and Related Research, 298, 156-164.

Roush, S.E. (1985). Patient-perceived functional outcomes associated with elective hip and knee arthroplasties. Physical Therapy, 65 (10), 1496-1500.

Spear, C.V. Jr (1990). Common pathologic problems of the hip In J. L. Echternach (Ed.), Physical therapy of the hip. New York: Churchill Livingstone.

Seto, J. L., & Brewster, C. E. (1991). Musculoskeletal conditioning of the older athlete. Clinics in Sports Medicine, 10 (2), 401-429.

Shih, C.H., Du, Y.K., Lin, Y.H., & Wu, C.C. (1994). Muscular recovery around the hip joint after total hip arthroplasty. Clinical Orthopaedics and Related Research, 302, 115-120.

Skinner, H.B. (1993). Pathokinesiology and total joint arthroplasty. Clinical Orthopaedics and Related Research, 288, 78-86.

Strickland, E.M., Fares, M., Krebs, D.E., Riley, P.O., Givens-Heiss, D.L., Hodge, W.A., & Mann, R.W. (1992). In vivo acetabular contact pressures during rehabilitation, part 1: Acute phase. Physical Therapy, 72 (10), 691-699.

Telford, R. D., Hooper, L. A., & Chennels, M. H. D. (1980). Calibration and comparison of air-braked and mechanically-braked bicycle ergometers. Australian Journal of Sports Medicine, 12, 41-46.

Thielen, P.L., & Mueller, K.H. (1973). Immediate postoperative management of patients with total hip replacement. Physical Therapy, 53 (9), 949-955.

Vasavada, A.N., Delp, S.L., Maloney, W.J., Schurman, D.J., & Zajac, F.E. (1994). Compensating for changes in muscle length in total hip arthroplasty: Effects on the moment generating capacity of the muscles. Clinical Orthopaedics and Related Research, 302, 121-133.

Visuri, T., & Honkanen, R. (1980). Total hip replacement: Its influence on spontaneous recreation exercise habits. Archives of Physical and Medical Rehabilitation, 61, 325-328.

Ware, J.E., & Sherbourne, C.D. (1992). The MOS 36-item short-form health survey (SF-36). I: Conceptual framework and item selection. Medical Care, 30, 473-483.

White, J. (1992). No more bump and grind. The Physician and Sportsmedicine, 20 (3), 223-228.

Wroblewski, B.M. (1993). Cementless versus cemented total hip arthroplasty. Orthopaedics Clinics of North America, 24 (4), 591-597.

Wroblewski, B.M., (1993). Charnley low-friction arthroplasty of the hip; Long-term results. Clinical Orthopaedics and Related Research, 292, 191-201.

APPENDIX D

Test-Retest Reliability Study Report

Contents list.

Introduction

In accordance with the exercise outcomes study protocol, a test-retest trial was required of relevant measuring techniques to detect and minimise any intra-tester inconsistencies. The SEIQoL, and the Harris Hip Scale do not lend themselves to short term repeated measures testing. The test-retest trial was therefore carried out on the 6-minute walk test, the muscle strength test technique and the aerobic power test.

Method

Subjects

The participants in the test-retest trial were eight female and two male patients, eight of whom had previously undergone hip or knee surgery, one subject had an osteoarthritic knee and was awaiting surgery, and one subject was a chronic arthritic not yet scheduled for surgery.

The mean age of the subjects was 60.8 (range 53-70 years). These subjects were regarded as representative of the subjects that were to be taking part in the main study.

6 minute walk

The literature indicated that walking tests are simple, inexpensive and safe (Guyatt et al., 1985). The action of walking may also relate more closely to the demands of activities of daily living than cycling, rowing or stepping ergometers. The use of treadmill testing while acceptable, may be intimidating for people using walking aids, and requires the use of expensive equipment which was not available for this study.

Many previous studies have used the 12-minute walk as the test protocol, but it has been demonstrated that a six-minute walk can produce equivalent results (Butland, Pang, Gross et al., 1982). The shorter time frame is efficient, potentially less stressful for the post-surgical patient, and corresponds well with the anticipated day-to-day activity levels of severely or moderately limited ambulation patients. The test was applied as described in the main study test protocol. (See Appendix G) Each subject was tested on two occasions approximately one week apart.

Walk test results.

The mean distance walked in the first test was 493.6 metres (range 272-722 metres), and in the second test the mean distance walked was 500.7 metres (range 289-741 metres). The correlation between the two sets of test data was .995. A two-tailed t-test on the pre and post-test data resulted in an obtained t-value of 1.71, which did not reach significance at the $p = .05$ level.

Muscle strength testing

Weakness in the hip musculature is a common feature in post-operative total hip replacement patients (Sashika, Matsuba, & Watanabe, 1996). Assessment and development of muscle strength plays a major role in the planning, prescription and modification of rehabilitation exercise programs for this population. Manual muscle testing (MMT) has been commonly used by physiotherapists to assess muscle strength, (Hislop & Montgomery, 1995), but the subjective grading systems that are often used in this procedure lack sensitivity (Wadsworth, Krishnan, Sear, Harrold, & Nielsen, 1987), and may not detect changes in muscle forces that differ by as much as 25% (Kramer, Vaz,

& Vandervoort, 1991). Alternative isometric measuring techniques using hand held dynamometers (HHD) have proved to be accurate and reliable, and relatively inexpensive when compared with larger dynamometers such as Cybex. For the population involved in this study, a dynamic measure of strength was preferred to an isometric measure because the technique seemed to produce less pain in joints affected by arthritis, was potentially less risky after recent total hip replacement, and was considered more appropriate for measuring strength gains from a dynamic exercise program.

The test-retest trial was carried out using a one repetition maximum (1RM) technique on a universal weight and pulley system. For the purpose of establishing intratester reliability with the measuring technique, hip abductors and knee extensors were tested on the same side on the 10 subjects on two separate occasions approximately one week apart.

Muscle test results

The mean values obtained for the abductor test was 7.70 Kg on the first test and 8.10 Kg on the second. The correlation between the two sets of data was .936. The differences between the two tests were not significant ($t = 1.33$). The mean values obtained for the knee extensor tests were 15.33 Kg and 15.82 Kg on the first and second tests respectively. Correlation was .875, and the differences were not significant on the two-tailed paired samples t-test ($t = 1.17$).

Aerobic power test

The weakening effects of hip replacement surgery, combined with probable pre-operative decline in physical condition, necessitate the use of cardiovascular exercise

testing and individualized endurance and strength training programs to facilitate functional rehabilitation, and return to normal activities of daily living. In the case of post-operative hip replacement patients, effective cardiovascular *training* requires the use of appropriate land and water based exercise regimens, and aerobic power *testing* is often best carried out using an ergometer that can protect the compromised joint while permitting a valid physiological assessment.

The main study utilised the Schwinn Airdyne cycle ergometer as a training and testing method, because of its unique construction which incorporates interconnected arm levers and foot pedals. This arrangement can provide an effective workout while protecting the affected joint. In the test-retest trial each of the ten subjects were tested on two occasions approximately one week apart according to the protocol in appendix G.

Aerobic power test results

The mean aerobic power attained in the two tests was very close at 40.1 Kcal on the first test and 41.1 Kcal on the second test. This is characteristic of experience to date with these ergometers, which are extremely accurate and give reproducible test results, particularly when perceived exertion and pulse rates are closely controlled. The correlation between the two sets of test data was .960, and the differences did not reach significance, despite the broad range of the individual aerobic power results - 40 Kcal on test 1, and 31 Kcal on test 2.

Conclusions

The subjects undergoing the tests were representative of the population taking part in the main hip exercise outcomes study. The results of the test-retest trial can be taken to

indicate that the measuring techniques as applied by the researcher to this sample are reliable, and will give reproducible test results and the possibility of detecting actual changes in individual outcomes.

Key References

Andrews, A.W., Thomas, M.W., Bohannon, R.W. (1996). Normative values for isometric muscle force measurements obtained with hand-held dynamometers. Physical Therapy, 76, (3), 248-259.

Bohannon, R.W. (1986). Manual muscle test scores and dynamometer test scores of knee extension strength. Archives of Physical and Medical Rehabilitation, 67, 390-392.

Bohannon, R.W., & Andrews, A.W. (1989). Accuracy of spring and strain gauge hand-held dynamometers. Journal of Orthopaedic and Sports Physical Therapy, 323-325.

Butland, R.J.A., Pang, J., Gross. E.R. et al, (1982). Two-, six-, and twelve-minute walking tests in respiratory disease. British Medical Journal, 284, 1607-1608.

Guyatt, G.H., Sullivan, M.J., Thompson, P.J., Fallen, E.L., Pugsley, S.O., Taylor, D.W., & Berman, L.B. (1985). The 6-minute walk. : A new measure of exercise capacity in patients with chronic heart failure. Canadian Medical Association Journal, 132, 919-922.

Kramer, J.F., Vaz, M.D., & Vandervoort, A.A. (1991). Reliability of isometric hip abductor torques during examiner- and belt-resisted tests. Journal of Gerontology, 46 (2), M47-M51.

Roush, S.E. (1985). Patient perceived functional outcomes associated with elective hip and knee arthroplasties. Physical Therapy, 65 (10), 1496-1500.

Sashika, H., Matsuba, Y., Watanabe, Y. (1996). Home program of physical therapy: Effect on disabilities of patients with total hip arthroplasty. Archives of Physical and Medical Rehabilitation, 77, 273-7.

Shih, C-H., Du, Y-K., Lin, Y-H., Wu, C-C. (1994). Muscular recovery around the hip after total hip arthroplasty. Clinical Orthopaedics and Related Research, 302, 115-120.

Wadsworth, C.T., Krishnan, R., Sear,M., Harrold, J., Nielsen, D.H. (1987). Intrarater reliability of manual muscle testing and hand-held dynametric muscle testing. Physical Therapy, 67, 1342-7.

APPENDIX E

Method

Subjects

Selection procedure

Medical approval letters

Informed consent

Evaluation instruments and protocols

Procedures flow chart

Method

Subjects

Subjects were volunteers obtained from the 1996/7 patient lists of participating surgeons operating at the Royal Jubilee Hospital in Victoria, British Columbia. A total of 23 subjects, 13 in the exercise group and 10 in the control group were utilized in the study. The available population base for this study related to a projected annual operating list for 1996/97 of approximately 320 patients. Personal details were kept confidential, and names of subjects were not used or associated with experimental data.

Subjects volunteering to take part in the study, were required to obtain the approval of their surgeon and/or physician, and were asked to give informed consent. Volunteer subjects from the THR operating list who were so functionally limited that they could not complete the baseline tests or could not carry out the exercise program were excluded from the study.

Subject selection procedure

1. The names of patients identified for surgery were supplied by the doctors' offices.
2. The offices were also requested to provide the ages of the patients so that potential subjects could be identified in the 60—75 year age group.
3. The patients were first contacted by telephone to ascertain if they were interested in taking part in the study. The patients were pre-selected to join the experimental exercise group or the control group, and they were asked to agree to be allocated in accordance with the preselection.

4. If interested in taking part in the study, the patients were invited to visit the exercise facility for interview. At the interview the project was explained in detail, an informed consent was obtained, and a simple questionnaire was used to obtain demographic details if required for future reference, concerning potential subjects' gender, age, occupational background, marital status, and their activity profile in the period leading up to the operation. (See Appendix H).

5. Formal approval to participate in the study was obtained from each individual's doctor.

6. An attempt was made to balance the participation between male and female patients as far as possible.

Control and experimental group subjects that enrolled of their own accord into an organised exercise program similar to that of the research study were excluded from taking part in the study.

Evaluation Instruments and Protocols

The following measures were used to evaluate outcomes from the study:

1. The Schedule for the Evaluation of Individual Quality of Life (SEIQoL)

(O'Boyle, McGee, Hickey, O'Malley, & Joyce, 1992)

A valid measure of QoL should quantify the level of functioning of each individual in those areas of life that he or she believes to be most important. Most QoL measures impose an external value system on patients by the use of standardized formats, usually derived from group data. Although such measures may be reliable, whether they are relevant to individual patients is unclear. The SEIQoL was devised from the technique known as judgement analysis to measure patients' level of functioning in five self nominated facets of life and the relative weight or importance attached to these areas.

O'Boyle et al. (1992) conducted a prospective intervention study on 20 unilateral hip replacement patients and compared them with 20 matched non-patient controls. Test-retest reliability of global QoL scores from t1 to t2 in the control subjects was $r = -0.88$.

In the application of the scale, subjects were asked to list the five areas of life, (cues), related to their physiological functioning, that they judged to be most important to their overall QoL. Open ended questions were asked to elicit the relevant cues, and most participants were able to provide five cues. In a case where a subject was unable to provide five cues the interviewer read from a list of possibilities as a prompt.

2. Harris Hip Scale, (Harris, 1969).

This is the scale recommended and used by the orthopaedic surgeons in Greater Victoria, selected by them after consideration of the relative effectiveness of 19 different

scales. The Harris scale was selected because it is accurate (Bryant, 1993), most commonly used, and not too complicated. It does not need an orthopaedic surgeon to administer it.

The Harris Hip Scale is recognized among orthopaedic surgeons as the gold standard used to assess physical status of patients with total joint replacements (Shields, Enloe, Evans, Smith, & Steckel, 1995). Shields et al. (1995) found a Pearson correlation of .86 between the Harris Hip Scale scores and five functional measures carried out by four therapists on 86 total joint replacement subjects, 49 of whom were THR patients. It has sub-scales as follows:

a) pain - subjective feelings and limitations

b) function - gait, walking performance and daily activities

c) deformity - fixed flexion, adduction, rotation, and limb length

d) range of motion - measured with range of motion protractor.

3. 6-minute walk test,

(Guyatt et al., 1985).

A 6 minute timed walk test over a measured indoor course was administered and evaluated separately to the overall Harris hip score. Subjects were asked to cover as much ground as they could in the allotted time, using walking aids as required. A predetermined set of encouraging phrases was delivered to subjects during the walk, such as "you're doing well." "keep up the good work". (Guyatt et al., 1985). The pulse rate was recorded at the end of the 6-minute walk test, which acted as a warm up for the

strength tests. The subject was observed for gait abnormalities during the walk. A 5-minute rest was allowed before commencing the muscle strength testing.

4. One repetition maximum (1RM) strength of certain muscle groups.

(Fiatarone et al., 1990) The dynamic strength of the operated hip abductors, adductors, extensors, and flexors, were measured using the 1RM technique. The test re-test trial carried out before the study (see appendix D) showed an intra tester correlation of .936 for a representative population.

5. Aerobic power using a Schwinn Airdyne windvane ergometer

(Bostom, Bates, Mazzerella, Block, & Adler, 1987; Nagle, Richie, & Giese, 1984; Telford, Hooper, & Chennels, 1980.)

The Schwinn Airdyne is a four element machine that allows any combination of bilateral or unilateral arm or leg cranking. This is ideal for exercising subjects who have upper or lower extremity joint disorders, as a painful limb can be rested while the others exercise. The machine is calibrated to indicate workload, and allows for accurate cardiovascular testing and training. A dynamometer calibration of the ergometer showed that, on average, the load readings were accurate to within 1% to 3%, whether accomplished with arms or legs or combined arms and legs (Bostom et al., 1987; Nagle et al., 1984). Subjects were tested for aerobic power at the beginning and end of the exercise program. Changes in aerobic power were estimated by determining maximum total Kcal/min output over a set period of 5 minutes, after adequate low-intensity warm-up.

Procedures

The methodology model (see fig. 1) sets out the research program and time scale. In the first phase of the study ❶ the design and methodology was defined, human subjects committee approval obtained, facility space identified, equipment purchased, and the test re-test reliability study carried out. THR operations ❷ are performed in the Greater Victoria district at the average rate of about six per week and, therefore, subjects did not all become available at the same time. As subjects were identified and documented ❸ they were randomly allocated to either the experimental or control group ❹ and followed one of two routes through the study program as shown in the model.

All subjects received current normal post-operative physiotherapy treatment ❻. At an average ten weeks after the operation all participants undertook baseline pre-testing ❼, the experimental group then commenced a specially designed eight week exercise program, and the control group had the option of regular therapy. The final tests were carried out eight weeks after the baseline pre-testing.

After the last set of evaluation measures, the inter-group physical profile comparisons and statistical analysis were carried out.

APPENDIX F

Exercise Program Content

Exercise Program Content (For detailed workout record sheet see Appendix H)

A standard exercise session consisted of:

1. Cardiovascular exercise on a Schwinn cycle ergometer using combined bilateral arm and leg, or bilateral arm and unilateral leg exercise, and on a Concept II Rowing Ergometer.
2. Strength training using variable resistance machines to isolate muscle groups being trained and to protect affected joints (Seto & Brewster, 1991)
3. Range of motion development and maintenance using a combination of resistance machines and free weights.
4. Stretching and flexibility of non symptom limited musculo-skeletal groups
5. Walking on a treadmill as tolerated to develop normal gait and endurance.

It was expected that participants would have different tolerance levels to the proposed training regimen depending on previous activity history, and that certain sections might need adaptation to meet individual needs. Prescribed exercises took into account the range-of-motion limitations appropriate to post-operative THR patients.

A typical standard exercise session began with a low-intensity 5 minute warm-up period on the cycle ergometer, allowing for a gradual increase in exercise intensity to a comfortable working level. The cardiovascular training section was gradually built up to a total of 15 minutes on the cycle ergometer, using a target heart rate of 70% heart rate reserve (HRR) and the Borg perceived exertion scale to monitor intensity.

The strength training section consisted of a range of machine based and free weight exercises to strengthen the major muscle groups of the body, with due consideration to those specific muscle groups affected by the previously diseased joint and by surgery. The gait and walking endurance development section was built up to six minutes of walking to observe and record mobility limitations and changes. The final section of each session included up to 15 minutes cardiovascular exercise, on the rowing ergometer, including a warm-down followed by easy stretching.

APPENDIX G

Test protocols

Test Protocols

Order of testing

The tests were carried out in the same order and, as far as was possible, at the same time of the day for each subject. The order of testing was as follows:

1. SEIQoL
2. record resting pulse rate
3. low intensity warm-up on the airdyne cycle (5 mins)
4. record pulse rate at end of warm-up
5. Harris Hip Scale (8-10 mins)
6. 6-minute walk test
7. record pulse rate at end of walk test
8. 5-minute rest
9. muscle strength tests (20-25 mins)
10. aerobic test on airdyne cycle (6-8 mins)

TOTAL TEST TIME - approx 60-75 mins

The evaluation tests were administered in accordance with the following protocols:

1. SEIQoL

This schedule is an interview based, fitness related, quality of life survey. It was completed by the research staff at each of the test sessions.

2. Resting pulse rate

The subject's resting pulse rate was noted at the beginning and end of the warm up using radial artery palpation.

3. Warm-up

A low intensity warm-up was carried out on the airdyne cycle, at approximately 40 rpm (5 Kcal/min).

4. Harris Hip Scale

Section 1, Pain: This sub-scale was an evaluation by the interviewer based on the subject's observations about the effects of pain on usual daily activities.

Section 2, Function: The gait score was evaluated as a combination of observed walking ability, assistance required, and the subject's estimate of walking distance tolerance.

Section 3 and 4, Absence of deformity and range of motion (ROM): ROM checks to determine function and possible presence of deformity were carried out using a ROM protractor. Hip flexion, abduction, adduction and extension were carried out with the subject in the standing position, and thigh internal and external rotation with the subject sitting. True limb length measurements were made in the supine position from the right and left anterior superior iliac spines (ASIS) to the medial malleolus of the corresponding leg. Apparent limb length measurements were made in the supine position from the umbilicus to the medial malleoli. Any tibial and femoral length discrepancies were detected by observation in this position with the the legs slightly flexed using the knees as a reference. (Echternach, 1990).

5. 6-minute walk test

A 6 minute timed walk test over a measured indoor course was administered. Subjects were asked to cover as much ground as they could in the allotted time, using walking aids as required. A predetermined set of encouraging phrases was delivered to subjects during the walk, such as "you're doing well." "keep up the good work" (Guyatt et al, 1985).

The pulse rate was recorded at the end of the 6-minute walk test, which acted as a warm up for the strength tests. The subject was observed for presence of gait abnormalities during the walk. A 5-minute rest was allowed before commencing the muscle strength testing.

6. Muscle strength testing.

The dynamic strength of hip abductors (gluteus medius and minimus), adductors (adductor longus group), extensors (gluteus maximus), and flexors (iliopsoas) were measured using a one repetition maximum (1RM) technique on a universal weight and pulley system. The one repetition maximum was defined as the highest weight the subject could move one time only through the available range of motion (ROM) of the respective muscle groups. After familiarization with the equipment and the testing procedure, muscle groups were tested sequentially, adding weight in small increments (1.0 Kg), resting 20 seconds between lifts, until the subject could no longer move the weight through the ROM.

7. Aerobic power test on the airdyne cycle.

The aerobic power test was preceded by a 2-3 minute low intensity warmup to elevate the HR to the individual subject's target zone. This was calculated using the Karvonen method to establish a 60% to 80% zone based on the heart rate reserve (HRR). This corresponds to a perceived exertion on the BORG scale of 11-13. The subjects worked at this level of exertion for 5-minutes and the total Kcal expended recorded. The Kcal total measured in this way is representative of the subject's sub-maximal short-term aerobic power, takes pain and disability limitations into account, and was preferred to a maximal test for this type of subject.

APPENDIX H

Documentation:

Demographic details

Client record

Test records

Work session record

THE INTRODUCTORY INTERVIEW.

When you come for your "intro" session, the program staff will show you the equipment in the gym, and you will be able to try some exercises, gently at first, to see what suits you best. The activities include mobility and stretching, easy strength development, and some cardio-vascular fitness training. The exercises are all designed to take into account your personal goals and preferences, and the special needs of hip surgery.

The program has been fully developed with the assistance and approval of your doctor and the orthopaedic surgeon.

Bring some loose, comfortable clothing with you to exercise in and some trainers or other soft shoes. Changing rooms and showers are available.

IT'S EASY TO GET FIT!

notes

contact phone numbers

Jim McLauchlan	592-1834
Gordon Head	472-4000

(Front desk, for last-minute messages)

WELCOME!

to the

University of Victoria Exercise and Hip Replacement Research Program

You have consented to take part in the UVIC exercise research program for total hip replacement patients.

This leaflet explains more about the program, and gives you information about the exercise and testing arrangements at the Gordon Head Complex of the University.

Please read it carefully, and bring it along with you to your introductory interview.

on:..... 93

.....at.....

WHY BEGIN AN EXERCISE PROGRAMME?

The best reason for beginning an exercise programme is a real desire to improve your quality of life through health and fitness. The UVIC program can help you to do this with exercises that are designed with you in mind. The exercise routines are designed by our qualified staff, and are meant for adults who may have been inactive for many years, and may also have other medical problems. They therefore take you **gradually** into a set of exercises that progress from an easy start. You'll find that the exercise does not have to hurt to be good for you!

Will you please answer the questions in this leaflet before you come along for your introductory session.

PLEASE HELP US WITH SOME USEFUL INFORMATION

Your personal details:

Name. . . . . .

Address. . . . . .

. . . . . .

Telephone . . . . . .

Your Doctor. . . . . .

Place of birth. . . . . .

(please tick appropriate boxes)

Sex ☐ male ☐ female

Age group. ☐ 16-44 ☐ 45-54 ☐ 55-64 ☐ 65 +

Marital status ☐ partner ☐ no partner

Dependent children ☐ yes ☐ no

Employment ☐ work full time ☐ work part time ☐ not working

What has been your main occupation?

. . . . . .

☐ yes ☐ no ☐ used to be

Comparing yourself to others of your own age and sex, would you say you are:

☐ more fit ☐ less fit ☐ the same?

☐ more healthy ☐ less healthy ☐ the same?

☐ more active ☐ less active ☐ the same?

do you think you get enough exercise to keep you fit and healthy? ☐ yes ☐ no

do you think most people get enough exercise in everyday life to keep them fit and healthy?

☐ yes ☐ no ☐ don't know

Is there an activity that you have difficulty with that you would like to be able to do more easily?

(e.g. stair climbing, walking,or walking uphill,, gardening, housework, sport,working etc.)

I would like to be able to:

. . . . . .

. . . . . .

. . . . . .

How will you get to the University when you attend for your exercise sessions?

☐ car ☐ bus ☐ walk ☐ other

University of Victoria - School of Physical Education GVHS - Orthopaedic Section

TOTAL HIP STUDY CLIENT RECORD - CONFIDENTIAL

****

)R SURGEON AGE FIRST NAME SURNAME

ESS D.O.B. START DATE:

TELEPHONE:

FIRST SEEN BY.....

TION: MEDICAL CATEGORY

'ED INFO:

'ATION:

RRED ACTIVITIES:

):

)LOGICAL PROFILE: FIRST SECOND

DATE

T.....m WEIGHT

B.M.I

=

R.H.R.

.....cm BP

.....cm HARRIS.

6-MIN walk

KCAL/5

COMMENTS: DATE..... SIGNATURE.....

progress notes over....

University of Victoria

School of Physical Education

REHABILITATION EXERCISE AND

TOTAL HIP REPLACEMENT

Recording Documentation

SUBJECT NAME:. . . . . .

STUDY REF #: . . . . . TEST #: . . . . . .

DATE: . . . . . .TIME: . . . . . .

1. SEIQoL

Elicited cues: List the five fitness related areas of life the subject judges to be most important to their overall quality of life, in order of relative importance 1-5.

	If limited, in what way?
1.....	.....
	as bad |.....|.....|.....|.....|.....| as good possible possible
2.....	.....
	as bad |.....|.....|.....|.....|.....| as good possible possible
3.....	.....
	as bad |.....|.....|.....|.....|.....| as good possible possible
4.....	.....
	as bad |.....|.....|.....|.....|.....| as good possible possible
5.....	.....
	as bad |.....|.....|.....|.....|.....| as good possible possible

Examples:

Social/leisure activities (bridge, golf, theatre, walking, gardening ??)
Family
Personal health (including activities of daily living)

Relationships	Religion
Finances	Work
Family health	Independence
Living conditions	Intellectual function
Happiness	"Feel good" factor

2. Resting pulse rate after survey . . . . . bpm

3. Warm-up on airdyne cycle (5 mins) - low intensity 30/40 rpm

seat hole number . . . . . .

cals expended . . . . . Kcal.

comments on warm-up:

4. Pulse rate at end of 5 min warm-up . . . . . bpm.

UNIVERSITY OF VICTORIA - SCHOOL OF PHYSICAL EDUCATION
EXERCISE AND HIP REPLACEMENT STUDY

HARRIS HIP SCALE - MODIFIED

TEST DATE . . . . . .

STUDY REF NO . . . . . .

1. Pain (44 possible) . . . . . (circle one)

A. none/ignores it	44
B. slight, no compromise in activity	40
C. mild pain, usual activities, may take ASA	30
D. moderate pain, concessions to pain	20
E. marked pain, serious limitations of activities	10
F. totally disabled with pain, bedridden	0

2. Function (47 possible) . . . . . (circle one in each category)

A. Gait (33 possible)

1. limp
   - a) none 11
   - b) slight 8
   - c) moderate 5
   - d) severe 0

2. support
   - a) none 11
   - b) cane for long walks 7
   - c) cane full time 2
   - d) two canes 4
   - e) two crutches or walker 0

3). walking tolerance
   - a) unlimited 11
   - b) 6 blocks (1 hour) 8
   - c) 2-3 blocks (1/2 hour) 5
   - d) indoors only 2
   - e) bed to chair only 0

B. Activities (14 possible)

1. Stairs
   - a) normally without railing 4
   - b) normally with railing 2
   - c) in any manner 1
     (with any type of assistance)
   - d) unable to do stairs 0

2. shoes and socks
   - a) with ease 4
   - b) with difficulty 2
   - c) unable 0

3. sitting
   - a) comfortably in ordinary chair 1 hr 5
   - b) on a raised chair for 1/2 hr . . . 3
   - c) unable to sit comfortably 0

4. public transport
   - a) able to use 1
   - b) not able 0

3. Absence of deformity . . . . . (circle those that apply)

A. less than 30 deg. fixed flexion contracture	1
B. less than 10 deg. fixed adduction	1
C. less than 10 deg fixed internal rotation in extension	1
D. limb length discrepancy less than 2.5 cm.	1

4. Range of motion . . . . . (circle one in each category)

A. Flexion
   - a) < 45 deg 0
   - b) 45-90 deg 1
   - c) 90 deg 1.5
   - d) > 90 deg 2

B. Abduction
   - a) < 10 deg 0
   - b) 10-20 deg 0.5
   - c) > 20 deg 1

C. Adduction
   - a) < 10 deg 0
   - b) > 10 deg 0.5

D. External rotation (in extension)
   - a) < 10 deg 0
   - b) 10-20 deg 0.5
   - c) > 20 deg 1

E. Internal rotation (in extension)
   - a) < 10 deg 0
   - b) > 10 deg 0.5

TOTAL . . . . . _____

UNIVERSITY OF VICTORIA
SCHOOL OF PHYSICAL EDUCATION
EXERCISE AND TOTAL HIP REPLACEMENT STUDY

SIX MINUTE WALK TEST RECORD

NAME . . . . STUDY REF #. . . . .

TEST #	DATE	TIME	DISTANCE IN 6 MINS.	AVERAGE SPEED m/sec	PULSE RATE AT END OF TEST
1					
2					

COMMENTS:
gait characteristics.
walking aids etc.

LAPS (38m)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

j86/mat

University of Victoria - School of Physical Education
Exercise and Total Hip Replacement Study

Muscle strength test record

Name . . . . . Study Ref # . . . . . .

muscle group		DATE test # 1 Kg	DATE test # 2 Kg
Abductors	left		
	right		
Adductors	left		
	right		
Flexors	left		
	right		
Extensors	left		
	right		

NOTES:

j89/mat

University of Victoria - School of Physical Education
Exercise and Total Hip Replacement Study

Aerobic Power Test Record.

Airdyne Cycle:

Seat pin hole number: . . . . . .

(threshold target heart rate [(220 - age) - RHR] x 60%] + RHR = ...)

(max intensity for test 80% of HRR = ...)

Low intensity warm-up to threshold target heart rate (. . . . .bpm) 2-3 mins.

- **Steady state condition at start of 5 min test run: rpm** . . . . . .

  HR bpm . . . . . .

- **working heart rate at half way point . . . . . bpm**

- **perceived exertion halfway point. . . . . .(Borg scale)**

- **heart rate at end of 5 min test run . . . . . bpm**

- **total energy expended during test run . . . . . Kcal.**

Comments on test:

OTAL REHAB - GHRC

NAME 102

		DATE Time		DATE Time		DATE Time		DATE Time		DATE Time	
ROBIC EXERCISES - and warm											
RDYNE BIKE (first 2 minutes warm up) CUMBENT		15									
WER (last 2 minutes warm down)		15									
EADMILL											
STRENGTH EXERCISES	**STRETCH (number)**	Total cal = cal / min =		Total cal = cal / min =		Total cal = cal / min =		Total cal = cal / min =		Total cal = cal / min =	
EST pec deck (8)	pectorals 1 & 5										
ER BACK vert lat (8)	deltoids, rhomboids, traps. 2										
MS/SIDES lat pull (1)	lats 3 & 4										
CEPS press down (2)	triceps, lats 3										
ER BODY vert press (3)	pecs, triceps 1 & 2										
ER BACK seated row (4)	gluts.lumbars 6										
S seated leg press (5)	quads,gluts 7 & 9										
- abduct (out) (6)	abductors 4										
- flex (up) (6)	flexors 8										
- adduct (in) (6)	adductors 8										
- extend (back) (6)	gluts/hams 10										
EXT. (aw or m/c) (7)	quads 7										
CURL (aw or m/c) (7)	hams 10										
OMINALS curl-ups vert twist (9) roman chair	abs 13 obliques 3 lower abs 13										
AL STABILIZATION (Floor mat)	abdominals, gluts, lumbars, hams	level		level		level		level		level	
did you feel today?											

APPENDIX I

Data Tables and Statistical Analysis Results

	pre test between groups	pre-post comparison within groups		post test between groups	Refer to results in table:
		experimental	controls		
Quality of Life (SEIQoL)	.866	.000*	.000*	.010*	5
Mobility/ADL (Harris Scale)	.088	.000*	.000*	.001*	6
Walking Dist. (6 min. walk)	.307	.000*	.002*	.012*	7
Strength (combined hip)	.420	.000*	.002*	.097	9
Aerobic power (5 min airdyne)	.406	.000*	.006*	.480	10

Table 1. Summary of p values obtained on t-tests.
* significant at alpha = .05

variable	between group comparisons	refer to results in table:
age	.570	4
test 1 timing	.733	
test 2 timing	.839	

Table 2. Summary of p values obtained from t-tests on age and test timing.
(no significant differences were found)

Variable	Mean	Std Dev	Minimum	Valid Maximum	N
AGEE	67.31	8.01	53	79	13
TESTW1E	10.31	3.57	6	16	13
TESTW2E	18.00	4.40	9	25	13
STR1E	25.66	8.51	12.50	42.80	13
STR2E	40.31	10.00	20.00	57.00	13
SEI1E	27.77	9.18	16	47	13
SEI2E	58.46	8.65	42	75	13
POW1E	31.85	11.13	18	51	13
POW2E	43.85	12.35	28	64	13
HAR1E	72.46	10.75	56	90	13
HAR2E	93.00	7.21	80	100	13
W1DISE	455.23	85.97	314	550	13
W2DISE	542.23	102.08	362	696	13

Variable	Mean	Std Dev	Minimum	Valid Maximum	N	Label
AGEC	65.10	10.35	43	76	10	
TESTW1C	9.70	4.88	6	22	10	
TESTW2C	17.60	4.88	13	30	10	
STR1C	28.75	9.44	15.00	45.00	10	
STR2C	33.38	8.75	20.50	45.00	10	
SEI1C	28.40	8.15	18	45	10	
SEI2C	49.10	6.51	40	64	10	
POW1C	35.70	10.34	26	61	10	
POW2C	40.20	11.67	28	68	10	
HAR1C	64.80	9.37	55	78	10	
HAR2C	81.60	7.66	70	99	10	
W1DISC	419.20	75.87	330	528	10	
W2DISC	438.30	71.75	352	550	10	

Table 3. Descriptive statistics of data

Variable	Mean	Std Dev	Minimum	Valid Maximum	N
TESTW1C	9.70	4.88	6	22	10
TESTW1E	10.31	3.57	6	16	13
TESTW2C	17.60	4.88	13	30	10
TESTW2E	18.00	4.40	9	25	13
AGEC	65.10	10.35	43	76	10
AGEE	67.31	8.01	53	79	13

Table 1. Age comparisons and post-op test timings.

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
TESTW1E				
GROUP 1	13	10.3077	3.568	.990
GROUP 2	10	9.7000	4.877	1.542

Mean Difference = .6077

Levene's Test for Equality of Variances: F= .017 P= .898

t-test for Equality of Means Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	.35	21	.733	1.758	(-3.049, 4.265)
Unequal	.33	15.91	.745	1.833	(-3.278, 4.493)

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
AGEE agee				
GROUP 1	13	67.3077	8.014	2.223
GROUP 2	10	65.1000	10.354	3.274

Mean Difference = 2.2077

Levene's Test for Equality of Variances: F= .588 P= .452

t-test for Equality of Means Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	.58	21	.570	3.824	(-5.747, 10.162)
Unequal	.56	16.57	.584	3.958	(-6.144, 10.559)

Table 4. Statistical test results for between group age and test timing comparisons

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
TESTW2E				
GROUP 1	13	18.0000	4.397	1.219
GROUP 2	10	17.6000	4.881	1.543

Mean Difference = .4000

Levene's Test for Equality of Variances: F= .178 P= .678

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	.21	21	.839	1.939	(-3.634, 4.434)
Unequal	.20	18.37	.841	1.967	(-3.734, 4.534)

Table 4. (Continued)

	names	sei1e	sei1c	sei2e	sei2c
1	1	31	27	62	48
2	2	16	21	56	64
3	3	30	21	42	40
4	4	29	18	60	42
5	5	38	29	63	52
6	6	32	26	63	50
7	7	20	45	64	51
8	8	32	37	58	50
9	9	16	33	50	46
10	10	25	27	52	48
11	11	29	.	66	.
12	12	47	.	75	.
13	13	16	.	49	.

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
SEI2E sei2e				
GROUP 1	13	58.4615	8.647	2.398
GROUP 2	10	49.1000	6.506	2.057

Mean Difference = 9.3615

Levene's Test for Equality of Variances: F= 1.396 P= .251

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	2.85	21	.010	3.281	(2.536, 16.187)
Unequal	2.96	21.00	.007	3.160	(2.789, 15.934)

Table 5. Quality of Life data and statistical test results.

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
SEI1E SEI1e				
GROUP 1	13	27.7692	9.185	2.547
GROUP 2	10	28.4000	8.154	2.579

Mean Difference = -.6308

Levene's Test for Equality of Variances: F= .189 P= .668

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	-.17	21	.866	3.684	(-8.293, 7.032)
Unequal	-.17	20.50	.864	3.625	(-8.193, 6.932)

- - - t-tests for paired samples - - -

Variable	Number of pairs	Corr	2-tail Sig	Mean	SD	SE of Mean
SEI1E SEI1e	13	.611	.026	27.7692	9.185	2.547
SEI2E sei2e				58.4615	8.647	2.398

Paired Differences			t-value	df	2-tail Sig
Mean	SD	SE of Mean			
-30.6923	7.878	2.185	-14.05	12	.000
95% CI (-35.454, -25.930)					

- - - t-tests for paired samples - - -

Variable	Number of pairs	Corr	2-tail Sig	Mean	SD	SE of Mean
SEI1C seilc	10	.123	.736	28.4000	8.154	2.579
SEI2C sei2c				49.1000	6.506	2.057

Paired Differences			t-value	df	2-tail Sig
Mean	SD	SE of Mean			
-20.7000	9.787	3.095	-6.69	9	.000
95% CI (-27.703, -13.697)					

Table 5. (Continued)

	har1e	har1c	har2e	har2c
1	90	76	100	85
2	75	78	89	99
3	69	59	88	84
4	75	58	97	80
5	56	58	88	76
6	76	55	100	76
7	71	61	88	80
8	62	70	83	84
9	84	56	100	70
10	81	77	97	82
11	64	.	100	.
12	83	.	99	.
13	56	.	80	.

t-tests for independent samples of GROUP

Variable	Number of Cases	Mean	SD	SE of Mean
HAR1E har1e				
GROUP 1	13	72.4615	10.752	2.982
GROUP 2	10	64.8000	9.367	2.962

Mean Difference = 7.6615

Levene's Test for Equality of Variances: F= .034 P= .855

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	1.79	21	.088	4.282	(-1.247, 16.570)
Unequal	1.82	20.61	.083	4.203	(-1.081, 16.404)

Table 6. Functional Capacity data and statistical test results

- - - t-tests for paired samples - - -

Variable	Number of pairs	Corr	2-tail Sig	Mean	SD	SE of Mean
HAR1E har1e	13	.744	.004	72.4615	10.752	2.982
HAR2E har2e				93.0000	7.211	2.000

Paired Differences Mean	SD	SE of Mean	t-value	df	2-tail Sig
-20.5385	7.230	2.005	-10.24	12	.000
95% CI (-24.908, -16.168)					

- - - t-tests for paired samples - - -

Variable	Number of pairs	Corr	2-tail Sig	Mean	SD	SE of Mean
HAR1C	10	.748	.013	64.8000	9.367	2.962
HAR2C				81.6000	7.662	2.423

Paired Differences Mean	SD	SE of Mean	t-value	df	2-tail Sig
-16.8000	6.250	1.977	-8.50	9	.000
95% CI (-21.272, -12.328)					

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
HAR2E har2e				
GROUP 1	13	93.0000	7.211	2.000
GROUP 2	10	81.6000	7.662	2.423

Mean Difference = 11.4000

Levene's Test for Equality of Variances: F= .557 P= .464

t-test for Equality of Means Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	3.66	21	.001	3.116	(4.919, 17.881)
Unequal	3.63	18.87	.002	3.142	(4.822, 17.978)

Table 6. (Continued)

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	w1dise	w1disc	w1spde	w1spdc	w2dise	w2disc	w2spde	w2spdc
1	550	440	1.53	.98	682	440	1.89	1.10
2	462	360	1.28	1.00	528	380	1.47	1.05
3	456	374	1.27	1.04	532	418	1.48	1.16
4	532	330	1.47	.85	556	352	1.54	.97
5	532	376	1.48	.98	696	410	1.93	1.10
6	494	354	1.37	.90	608	362	1.69	.97
7	352	506	.97	1.40	396	525	1.10	1.49
8	314	528	.87	1.47	456	528	1.27	1.47
9	380	396	1.06	1.10	475	418	1.32	1.16
10	532	528	1.47	1.47	646	550	1.79	1.53
11	462	.	1.28	.	550	.	1.53	.
12	532	.	1.47	.	562	.	1.56	.
13	320	.	.86	.	362	.	1.00	.

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
W2DISE w2dise				
GROUP 1	13	542.2308	102.080	28.312
GROUP 2	10	438.3000	71.753	22.690

Mean Difference = 103.9308

Levene's Test for Equality of Variances: F= .769 P= .390

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	2.74	21	.012	37.998	(24.890, 182.971)
Unequal	2.86	20.88	.009	36.282	(28.459, 179.402)

Table 7. Walking Distance data and statistical test results

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
W1DISE w1dise				
GROUP 1	13	455.2308	85.975	23.845
GROUP 2	10	419.2000	75.867	23.991

Mean Difference = 36.0308

Levene's Test for Equality of Variances: F= .084 P= .775

t-test for Equality of Means Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	1.05	21	.307	34.405	(-35.536, 107.597)
Unequal	1.07	20.53	.299	33.826	(-34.330, 106.392)

- - - t-tests for paired samples - - -

Variable		Number of pairs	Corr	2-tail Sig	Mean	SD	SE of Mean
W1DISE	w1dise	13	.900	.000	455.2308	85.975	23.845
W2DISE	w2dise				542.2308	102.080	28.312

Paired Differences Mean	SD	SE of Mean	t-value	df	2-tail Sig
-87.0000	44.866	12.444	-6.99	12	.000
95% CI (-114.120, -59.880)					

- - - t-tests for paired samples - - -

Variable	Number of pairs	Corr	2-tail Sig	Mean	SD	SE of Mean
W1DISC	10	.984	.000	419.2000	75.867	23.991
W2DISC				438.3000	71.753	22.690

Paired Differences Mean	SD	SE of Mean	t-value	df	2-tail Sig
-19.1000	13.828	4.373	-4.37	9	.002
95% CI (-28.995, -9.205)					

Table 7. (Continued)

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	abd1e	abd1c	abd2e	abd2c	add1e	add1c	add2e	add2c	flex1e	flex1c	flex2e	flex2c	ext1e	ext1c	ext2e	ext2c
1	7.5	5.00	8.5	5.00	12.5	10.50	16.0	12.50	7.5	10.50	12.5	12.50	15.0	12.50	20.0	15.00
2	4.5	10.25	9.0	12.00	9.0	11.25	13.6	12.25	6.8	11.25	11.4	15.00	9.0	12.25	14.8	15.00
3	3.4	5.00	5.7	5.00	5.7	7.50	8.0	7.50	4.5	7.50	6.8	10.00	5.7	12.50	8.0	15.00
4	5.7	2.50	9.1	2.50	6.8	2.50	11.4	5.00	5.7	5.00	10.2	7.50	9.1	5.00	13.6	7.50
5	3.4	5.00	6.8	5.00	4.5	10.00	10.2	10.00	5.7	5.00	10.2	7.50	5.7	10.00	11.4	10.00
6	2.3	3.00	6.8	3.50	4.5	3.50	10.2	3.50	3.4	5.00	10.2	6.00	5.7	7.50	10.2	7.50
7	2.5	5.00	5.0	5.00	5.0	7.50	10.0	7.50	5.0	5.00	7.5	7.50	5.0	10.00	10.0	12.50
8	1.1	7.50	4.5	7.50	9.1	7.50	11.4	10.00	6.8	7.50	9.1	10.00	10.2	10.00	11.4	15.00
9	4.5	2.50	7.5	2.50	7.5	5.00	10.5	7.50	6.5	5.00	10.5	7.50	8.4	5.00	13.4	7.50
10	4.8	2.50	7.2	2.50	8.4	10.00	9.4	10.00	7.5	5.00	9.5	7.50	6.8	12.50	12.5	12.50
11	5.0	.	7.5	.	7.5	.	12.5	.	7.5	.	13.0	.	12.5	.	17.5	.
12	2.5	.	5.0	.	10.0	.	15.0	.	10.0	.	15.0	.	12.5	.	15.0	.
13	2.5	.	2.5	.	2.5	.	5.0	.	2.5	.	5.0	.	5.0	.	7.5	.

Table 8. Individual muscle groups strength data.

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	str1e	str1c	str2e	str2c
1	42.80	38.50	57.00	45.00
2	29.30	45.00	48.80	43.25
3	19.30	32.50	28.50	37.50
4	27.90	15.00	44.30	22.50
5	19.30	30.00	38.60	32.50
6	15.90	19.00	37.40	20.50
7	17.50	27.50	32.50	32.50
8	27.20	32.50	36.40	42.50
9	26.90	17.50	41.90	25.00
10	27.50	30.00	38.60	32.50
11	32.50	.	50.00	.
12	35.00	.	50.00	.
13	12.50	.	20.00	.

Table 9. Combined strength data, and statistical test results. (combined strength data was obtained by adding the strength results for individual muscle groups.)

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
STR1E				
GROUP 1	13	25.6615	8.511	2.361
GROUP 2	10	28.7500	9.444	2.986

Mean Difference = -3.0885

Levene's Test for Equality of Variances: F= .045 P= .835

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	-.82	21	.420	3.753	(-10.895, 4.718)
Unequal	-.81	18.38	.428	3.807	(-11.088, 4.911)

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
STR2E				
GROUP 1	13	40.3077	9.998	2.773
GROUP 2	10	33.3750	8.752	2.768

Mean Difference = 6.9327

Levene's Test for Equality of Variances: F= .110 P= .743

t-test for Equality of Means Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	1.74	21	.097	3.989	(-1.365, 15.231)
Unequal	1.77	20.58	.092	3.918	(-1.217, 15.082)

- - - t-tests for paired samples - - -

Variable	Number of pairs	Corr	2-tail Sig	Mean	SD	SE of Mean
STR1C	10	.930	.000	28.7500	9.444	2.986
STR2C				33.3750	8.752	2.768

Paired Differences Mean	SD	SE of Mean	t-value	df	2-tail Sig
-4.6250	3.475	1.099	-4.21	9	.002
95% CI (-7.111, -2.139)					

- - - t-tests for paired samples - - -

Variable	Number of pairs	Corr	2-tail Sig	Mean	SD	SE of Mean
STR1E	13	.902	.000	25.6615	8.511	2.361
STR2E				40.3077	9.998	2.773

Paired Differences Mean	SD	SE of Mean	t-value	df	2-tail Sig
-14.6462	4.349	1.206	-12.14	12	.000
95% CI (-17.275, -12.017)					

Table 9. (Continued)

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	pow1e	pow1c	pow2e	pow2c
1	51	31	56	41
2	32	61	37	68
3	21	36	31	38
4	31	28	42	30
5	47	26	64	28
6	23	26	47	28
7	20	36	30	42
8	18	33	33	45
9	31	38	38	38
10	45	42	63	44
11	34	.	51	.
12	40	.	50	.
13	21	.	28	.

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
POW1E powle				
GROUP 1	13	31.8462	11.134	3.088
GROUP 2	10	35.7000	10.339	3.270

Mean Difference = -3.8538

Levene's Test for Equality of Variances: F= .510 P= .483

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	-.85	21	.406	4.543	(-13.304, 5.596)
Unequal	-.86	20.18	.402	4.497	(-13.238, 5.530)

Table 10. Aerobic Power data and statistical test results

t-tests for independent samples

Variable	Number of Cases	Mean	SD	SE of Mean
POW2E pow2c				
GROUP 1	13	43.8462	12.348	3.425
GROUP 2	10	40.2000	11.670	3.690

Mean Difference = 3.6462

Levene's Test for Equality of Variances: F= .811 P= .378

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	.72	21	.480	5.074	(-6.907, 14.200)
Unequal	.72	20.03	.477	5.035	(-6.858, 14.151)

- - - t-tests for paired samples - - -

Variable	Number of pairs	Corr	2-tail Sig	Mean	SD	SE of Mean
POW1C	10	.940	.000	35.7000	10.339	3.270
POW2C				40.2000	11.670	3.690

Paired Differences			t-value	df	2-tail Sig
Mean	SD	SE of Mean			
-4.5000	4.035	1.276	-3.53	9	.006
95% CI (-7.387, -1.613)					

- - - t-tests for paired samples - - -

Variable	Number of pairs	Corr	2-tail Sig	Mean	SD	SE of Mean
POW1E pow1e	13	.884	.000	31.8462	11.134	3.088
POW2E pow2e				43.8462	12.348	3.425

Paired Differences			t-value	df	2-tail Sig
Mean	SD	SE of Mean			
-12.0000	5.774	1.601	-7.49	12	.000
95% CI (-15.490, -8.510)					

Table 10. (Continued)

```
   * * *  C E L L   M E A N S  * * *

            SEI2E     sei2e
          by GROUP
Total Population
    54.39
 (    23)
GROUP
        1         2
    58.46     49.10
 (    13)  (    10)
```

```
          * * *  A N A L Y S I S   O F   V A R I A N C E  * * *

               SEI2E    sei2e
          by   GROUP
          with SEI1E    SEI1e
               EXPERIMENTAL sums of squares
               Covariates entered FIRST
```

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Covariates	228.889	1	228.889	4.475	.047
SEI1E	228.889	1	228.889	4.475	.047
Main Effects	521.540	1	521.540	10.196	.005
GROUP	521.540	1	521.540	10.196	.005
Explained	750.429	2	375.214	7.335	.004
Residual	1023.050	20	51.152		
Total	1773.478	22	80.613		

```
53 cases were processed.
30 cases (56.6 pct) were missing.
```

Table 11. ANCOVA pre-post between group statistical results for Quality of Life

```
  * * *  C E L L   M E A N S  * * *
              HAR2E     har2e
            by GROUP
Total Population
    88.04
 (    23)
GROUP
        1          2
    93.00      81.60
 (    13)   (    10)

           * * *  A N A L Y S I S   O F   V A R I A N C E  * * *

                HAR2E    har2e
           by   GROUP
           with HAR1E    har1e

                EXPERIMENTAL sums of squares
                Covariates entered FIRST
```

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Covariates	1110.227	1	1110.227	42.870	.000
HAR1E	1110.227	1	1110.227	42.870	.000
Main Effects	258.782	1	258.782	9.993	.005
GROUP	258.782	1	258.782	9.993	.005
Explained	1369.009	2	684.504	26.431	.000
Residual	517.948	20	25.897		
Total	1886.957	22	85.771		

```
53 cases were processed.
30 cases (56.6 pct) were missing.
```

Table 12. ANCOVA pre-post between group statistical results for Functional Capacity

```
                    * * *  C E L L   M E A N S  * * *

            W2DISE    w2dise
          by GROUP
Total Population
   497.04
 (    23)
GROUP
        1          2
   542.23     438.30
 (    13)   (    10)


          * * *  A N A L Y S I S   O F   V A R I A N C E  * * *
               W2DISE   w2dise
          by   GROUP
          with W1DISE   w1dise
               EXPERIMENTAL sums of squares
               Covariates entered FIRST

                                  Sum of                    Mean                 Sig
Source of Variation              Squares      DF           Square        F      of F
Covariates                    182300.720       1       182300.720   141.141   .000
   W1DISE                     182300.720       1       182300.720   141.141   .000
Main Effects                   24299.849       1        24299.849    18.813   .000
   GROUP                       24299.849       1        24299.849    18.813   .000
Explained                     206600.568       2       103300.284    79.977   .000
Residual                       25832.388      20         1291.619
Total                         232432.957      22        10565.134


53 cases were processed.
30 cases (56.6 pct) were missing.
```

Table 13. ANCOVA pre-post between group statistical results for Walking Distance

* * * C E L L M E A N S * * *

STR2E
by GROUP

Total Population
37.29
(23)

GROUP
1 2
40.31 33.38
(13) (10)

* * * A N A L Y S I S O F V A R I A N C E * * *

STR2E
by GROUP
with STR1E
EXPERIMENTAL sums of squares
Covariates entered FIRST

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Covariates	1289.092	1	1289.092	77.306	.000
STR1E	1289.092	1	1289.092	77.306	.000
Main Effects	537.917	1	537.917	32.259	.000
GROUP	537.917	1	537.917	32.259	.000
Explained	1827.009	2	913.504	54.782	.000
Residual	333.503	20	16.675		
Total	2160.512	22	98.205		

53 cases were processed.
30 cases (56.6 pct) were missing.

Table 14. ANCOVA pre-post between group statistical results for Muscle Strength

```
* * *  C E L L   M E A N S  * * *

            POW2E     pow2e
          by GROUP

Total Population
    42.26
(    23)
GROUP
        1         2
    43.85     40.20
(    13)  (    10)

          * * *  A N A L Y S I S   O F   V A R I A N C E  * * *

               POW2E    pow2e
          by   GROUP
          with POW1E    pow1e
               EXPERIMENTAL sums of squares
               Covariates entered FIRST
```

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Covariates	2273.073	1	2273.073	83.241	.000
POW1E	2273.073	1	2273.073	83.241	.000
Main Effects	311.217	1	311.217	11.397	.003
GROUP	311.217	1	311.217	11.397	.003
Explained	2584.290	2	1292.145	47.319	.000
Residual	546.145	20	27.307		
Total	3130.435	22	142.292		

```
53 cases were processed.
30 cases (56.6 pct) were missing.
```

Table 15. ANCOVA pre-post between group statistical results for Aerobic Power

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Prescribed Post-Operative Exercise Following Total Hip Replacement Surgery

Author: 

James McLauchlan

April 23, 1999

VITA

Surname: McLauchlan Given Names: James

Place of Birth: London, England.

Educational Institutions Attended:

University of Victoria	1994 to 1999
University of Brighton, England	1988 to 1992

Degrees Awarded:

B.Sc. (Honours).	University of Brighton	1992