Development of an exercise intervention as part of rehabilitation in a glioblastoma multiforme survivor during irradiation treatment

a case report

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Development of an Exercise Intervention as part of Rehabilitation in a Glioblastoma Multiforme Survivor during Irradiation Treatment: A Case-Report

Running head: Exercise Rehabilitation

Key words: Brain tumour, Outpatient rehabilitation, Physical therapy

Article category: Case report

Abstract

Introduction

This case report describes the rationale and development of an exercise intervention in a patient with Glioblastoma Multiforme and discusses potential relations of observed effects in functional performance and quality of life.

Methods

A 54-year-old Glioblastoma Multiforme survivor completed a supervised six-week exercise intervention during irradiation treatment beginning 42 days after resection. Exercise modalities of cardiorespiratory, resistance-, and balance training were designed on generic recommendations of various cancer populations and literature review.

Results

Our case attended all possible sessions without experiencing adverse effects, and improved in aerobe power (24%), muscle strength (0-38%), standing balance (71%), walking ability (9%), and quality of life domains of ‘Global Health Status/QoL’ and ‘Physical functioning’.

Conclusion

Based on this single case, exercise rehabilitation has the ability to maintain or improve
functional performance and quality of life domains even during heavy treatments. It also implies that patients with Glioblastoma Multiforme are capable and may be willing to participate in exercise rehabilitation if supervised by physical therapists.

Keywords
Brain tumour; Outpatient Rehabilitation; Physical Therapy;

Introduction
Formerly, it was a prevailing belief that patients with cancer could not safely take part in, and would receive no benefits from exercise rehabilitation. Over the last decades, extensive research of the therapeutic effectiveness of exercise after a cancer diagnosis has changed the discursive approach to the perception of exercise rehabilitation and cancer[1]. Today, it is recommended that physical exercise should be offered all patients with a cancer diagnosis, given that the patients’ general condition does not contradict[2]. Exercise, as a part of rehabilitation, can prevent, attenuate, or treat physiological and psychological challenges experienced by cancer survivors [3]. Though this evidence is produced primarily from trials of patients with breast, colon, prostate, or hematologic cancers, it is recommended that also patients with malignant glioma attend rehabilitation[4], and may benefit from exercise[5]. Still, there is limited evidence as malignant gliomas represent an overt vulnerable and unique population of brain tumours, with characteristic functional, emotional, or cognitive impairments. These impairments may significantly affect quality of life (QOL), and restrict participation in rehabilitation and exercise interventions[6]. However, this should not promote an attitude of nihilism. Patients with brain tumours can improve functioning from rehabilitation even years after diagnosis [7]. This provides the theoretical rationale that
rehabilitation, including exercise, may improve functional and psychosocial adjustments during primary anticancer treatments. To recommend exercise rehabilitation to this patient group in the future, we need more knowledge and detailed descriptions of the exercises. This includes specifications on intensity, repetitions, and criteria for selection of particular exercises to include in the program. This case-report deals with a Glioblastoma Multiforme (GBM) survivor during active chemo-radiation treatments. The purpose was to describe the rationale and development of an exercise intervention, as part of rehabilitation, and to discuss potential relations of observed effects in physical function and QOL.

Patient description

This case-report was designed on the case-report guidelines (CARE)[8]. It was nested within a randomized controlled trial that investigates the effectiveness of intensive rehabilitation efforts of occupational and physical therapy in patients with glioma[9]. The report was carried out in agreement with the Helsinki Declaration and its later amendments. The local Research Ethics Committee in Denmark approved it under project id: S-20140108. The intervention began after an informed consent was signed.

The case was selected based on representativeness to the general randomized controlled trial population of patients with GBM and Karnofsky performance status ≥70[10]. A 54-year-old male was admitted to Odense University Hospital, Denmark because of decreasing motor functions over the past months. Before hospital admission, he increasingly stumbled and bumped into objects at his left side. In addition, his ability to play soccer and golf gradually disappeared. An MRI-scan confirmed the location of a tumour in the posterior part of his parietal lobe. After surgical resection, the histopathological diagnosis of GBM was established. A post resecting MRI-scan showed no measurable residual tumour. He was
offered full medical treatment for GBM, including radiotherapy of 33 fractions, with concomitant and adjuvant chemotherapy.

Clinical finding

At inclusion, 42 days after resection and at the third day of radiation treatment, our case was clinically examined by a physical therapist (LM) experienced in treating patients with various neurological conditions. In addition, his medical chart was reviewed by a neurooncologist (DB) who found no serious objections to exercising.

He presented with homonym hemianopia, hemispatial neglect toward his left body side, and impaired balance. Despite self-rating a higher ‘Emotional functioning’ by the European Organization of Research and Treatment of Cancer questionnaire (EORTC-QLQ-C30) (q21-24), his scores were comparable to EORTC-QLQ-C30 reference baseline values of patients with brain cancers[11].

He was subjectively evaluated with a Karnofsky performance status of 80, which indicates functional independency. Although he displayed impaired balance matched to healthy older controls[12] and his aerobe power was lower than healthy Nordic comparisons[13], his lower extremity muscle strength and walking ability were comparable to normative values of sex-aged matched healthy adults[14, 15]. Based on an answer from the Physical Activity questionnaire published by Saltin and Grimby in 1968[16] our case adhered to The American College of Sports Medicine exercise recommendations for adults[17], as he rated to be physically active for at least four hours a week in leisure time.

Outcome measures

Outcome measures were assessed at baseline (T1), and at the end of the six-week intervention (T2). Figure 1 gives an overview of the study course from surgery to the conclusion of the
intervention. The questionnaire used was the generic EORTC-QLQ-C30, due to its comprehensively psychometric testing[18]. High scores indicate better QOL for ‘Global Health Status/QOL’ and functioning scales, and poorer QOL for symptom scale/items[19].

Functional performance was defined by quantitative measures of (i) maximum dynamic muscle strength of knee extension, knee flexion, elbow flexion, elbow extension and leg press, (ii) aerobe power, (iii) balance, and (iv) walking ability.

He was instructed to abstain from strenuous activity for 24 hours before assessments and to avoid alcohol and smoking. Because T1 and T2 assessments were conducted immediately after the radiation treatment, he had not eaten two hours prior to testing.

Dynamic muscle strength was assessed by the repetition maximum principle where 1 repetition maximum for a given exercise is the maximum load that can be handled in a single execution. He performed a 3-8 repetition maximum test. 1 repetition maximum loads were predicted by Brzycki’s equation[20].

Aerobe power was assessed by the Aastrand-Rhyming cycle ergometer test, a single stage 6-minute submaximal exercise test, which predicts maximum oxygen uptake values [21]. The endpoint is based on a linear relationship between maximum oxygen uptake and heart rate. The workload pulse was supervised using a wireless heart rate transmitter (Polar FT40). Resistance (Watt) was increased to produce a steady-state heart rate between 110 and 170 beats/min. at 60 rounds per minute. If the heart rate after six minutes was >110 and <170 beats/min. without fluctuating more than five beats/min. the test was complete. Aerobe power was predicted using a nomogram with an age and body weight correction factor and stated in mlO².kg⁻¹.min⁻¹ [21].
Walking ability was assessed by a 10-meter walking test. Three trials of 10-meter walking from a stationary position at habitual speed were performed. Time was registered with a stopwatch able to record 1/100 seconds. Sum scores were used to estimate gait performance (m/s)[22].

A Nintendo Wii Balance Board using the custom-written software in Matlab assessed static balance. A 30-second, double-limb standing test with feet together, hands placed on contralateral shoulders, and eyes open was performed to a total of three successful trials. The case was instructed to remain still for the duration of the trial. Between trials, 30 seconds of rest was given. The outcome measure used was the sum score of the variance in centre of pressure (cm²). This method has compared to force platforms shown equally high validity [23].

Place fig. 1 about here: study overview

Exercise modalities

A decrease in functional performance or activity levels caused by the diagnosis or the related treatments may lead to inactivity. Sedentary behaviour can impair aerobic power and muscle strength, which limits the ability to perform simple daily activities. Low daily activity levels may significantly affect psychological outcomes as isolation and depression that strongly influences QOL[6]. We believe that a key factor for reversing this negative cascade is exercising, as it can improve strength, fitness, and functions of various cancer populations[5, 24]. Further, exercise as part of a rehabilitation of patients from a health event can improve QOL[25]. As such, it seems likely that these gains also apply patients with glioma.
Cardiorespiratory exercise

Patients with glioma often present with low aerobe power. A study reported an average maximum oxygen uptake indexed to weight as 13 mlO₂.kg⁻¹.min⁻¹, which equals to 41±10% of what could be predicted for age and sex-matched sedentary comparisons[26]. This was despite patients being functional independent (Karnofsky performance status ≥70). Though the clinical impact of a low maximum oxygen uptake of patients with glioma remains unknown, it may be important as it is a strong independent predictor of mortality in populations with heart conditions[27].

Amount of cardiorespiratory exercise

No study has described the ideal amount of exercise in patients with GBM. However, The American College of Sports Medicine has created guidelines that recommend patients with cancer to take part in cardiorespiratory activity of moderate-intensity for at least 150min/week, or cardiorespiratory activity of vigorous-intensity for 75min/week[2]. Until specific recommendations for patients with GBM appear, the existing evidence documenting benefits of exercise rehabilitation of patients with cancer, in general, applies to GBM survivors.

Resistance training

Patients with GBM often receive high and extended doses of concomitant steroids that together with sedentary behaviour can affect clinical outcomes such as musculoskeletal atrophy, weakness, abnormalities in myofibrillar mass, mitochondrial volume, and capillary number, which may affect the ability to perform daily activities[28, 29]. Decreased maximum muscle strength of knee extension has been observed in patients with gliomas to be lower than expected sex and age-matched comparisons [26, 28]. Because resistance training is crucial to
increasing muscle mass and preventing deterioration of functional performance it is indicated for patients with GBM.

**Amount of resistance training**

In cancer rehabilitation as well as in public health studies the recommended amount of resistance training is two to three sessions a week for at least six weeks to induce muscular hypertrophy. In addition, the recommendation is to include large muscle groups at 60–75% of 1 repetition maximum in one to three sets[30].

**Therapeutic target exercises based on impairments**

Depending on tumour location patients may experience various functional or cognitive impairments. Our case presented with impaired balance. Centre of pressure controlled video-games played on Nintendo Wii balance board have been reported to improve dynamic balance, prevent falls, and to increase motivation in a patient with a brain tumour[31]. Also, manual physical therapy guided exercises focusing on the lumbar multifidus, transverse abdominus and the quadratus lumborum that form the primary stability of the lumbar spine[32] together with diaphragm and the pelvis floor may impact standing balance, as “core stability” exercises decreases centre of pressure areas in young adults[33]. This implies that balance games played on Nintendo Wii balance board and “core stability” exercises may decrease centre of pressure areas and improve balance in patients with gliomas.

**Amount of targeted therapeutic exercises based on impairments**

Patients with brain tumours attending inpatient rehabilitation attain effects analogue to patients with stroke and traumatic brain injury, which present with comparable impairments in functioning [34]. This corroborates that patients with GBM may acquire similar effects in
the balance as in patients with stroke. In stroke rehabilitation, 20 minutes for 20 days can increase “core stability”, standing balance, and mobility[35]. This provides the rationale that patients with GBM may achieve effects from 15 minutes balance exercise per session.

Exercise intervention

The intervention included three sessions per week for six weeks (Monday, Wednesday, Friday) supervised by physical therapists. All sessions were performed in continuation of the irradiation treatment as the case was already attending the hospital.

All sessions included five to ten minutes warm-up on treadmill or exercise cycle with loads increasing from 65% to 75% of the heart rate reserve. Warm-up was followed by 20 minutes of cardiorespiratory training (cycling [SCIFIT ISO1000] or treadmill [SCIFIT AC5000]) with intensities close to 75% of the heart rate reserve.

Resistance exercises were aimed at accomplishing three continuous series with loads progressing from 12 to 10 repetitions (70-75%) of 1 repetition maximum. The selection of resistance exercises included large extremity muscles or synergies. To optimize safety range-of-motion–limiting equipment that minimizes multi-joint movements and balance was preferred. All resistance exercises were made dual-handed or legged and involved; leg press (targeting knee extensors, hip extensors, hip adductors and ankle joint flexors); elbow flexion (targeting m. biceps brachii, m. brachialis, m. brachioradialis); elbow extension (targeting m. triceps brachii); knee extension (targeting m. quadriceps femoris); knee flexion (targeting m. sartorius, m. gracilis, m. biceps femoris, m. semimembranosus, m. semitendinosus, m. gastrocnemius and m. plantaris) [Tuffstuff 804, 806, 830].
Fifteen minutes of balance exercises were performed using Nintendo Wii balance board games (Wii Fit Plus) or performing exercises on a Therapist Ball guided by a physical therapist (table 1).

Place table 1: Balance exercises about here

All loads/intensities were customized according to the literature and the cases pre-intervention cardiorespiratory function, muscle strength, balance, and functional impairments. Adjustments were made in accordance with daily functioning or adverse effects of the medical treatment. Before each session, precautionary screenings were conducted[9].

Place table 2 about here (Training diary)

Follow-up and outcomes
The case attended all 15 possible exercise sessions during the intervention (adherence 100%). He performed all resistance- and cardiorespiratory exercises at each session (compliance 100%) without experiencing any exercise-induced discomfort. Although daily functioning affected his performances and ability to overcome resistances, he generally increased cycling distance, adhered to progression in resistance training, and was stable in increasing points while playing games on Nintendo Wii balance board (table 2).

Besides elbow extension he improved in all functional performance measures; aerobe power (24%); leg press (11%); knee flexion (35%); knee extension (38%); and elbow flexion (17%). Walking ability improved 9% and standing balance 71% (table 3). Compared to baseline scores of EORTC-QLQ-30 (table 4) he improved ‘Global Health Status/QOL’ (8.6%), and ‘Physical functioning’ (6.7%). Despite a decrease in ‘Social functioning’ (16.7%), he was
stable in functioning scales. Symptomatology of ‘Dyspnoea’ and ‘Insomnia’ decreased (33.3%).

Place table 3 + 4 about here (Functional Performance & QOL)

Discussion

A clear description of interventions is needed to advance physical therapy interventions. It also improves implementing research into clinical practice. This case report has presented the rationale for developing an exercise program, as part of a rehabilitation intervention in a GBM survivor during chemo-radiation treatment. Our case completed a six-week intervention of cardiorespiratory-, resistance-, and balance training with the intention to avert regressions in functional performance and QOL during anticancer treatments.

The diagnosis of GBM peaks among people aged 75 to 84 and has a median age of 64 years at diagnosis[36]. Though our case had comparable QOL as (pre-medical treatment) reference values of EORTC-QOL-30 baseline data[11], his age reduces the representativeness to the entire GBM population. However, performance status and age are among the best described prognostic factors in GBM, and most likely there is a strong relation between high-performance status and lower age[37]. Mean age in studies of patients with gliomas attending outpatient rehabilitation or physical capacity assessments ranges between 34 and 61[7, 26, 28, 38, 39, 40, 41, 42, 43, 44]. This implies that exercise rehabilitation intervention mainly addresses the younger population or patients with high Karnofsky performance status, which makes our case highly representative of this glioma population. No reports have stated the ideal amount of exercise to patients with glioma. This intervention followed recommendations from the American College of Sports Medicine for cancer survivors[2]. Our case attained 100% adherence and compliance to the exercise intervention, and he tolerated the given intensities without adverse effects. The complete adherence and compliance imply that the
general exercise recommendations to patients with cancer are achievable in patients with GBM presenting with ≥70 Karnofsky performance status.

In an institution-based retrospective survey of 106 patients with primary brain cancer, 45% was interested in taking part in a physical activity program during adjuvant treatment and 47% felt able to take part in an exercise program during active treatment[45]. In a less powered study (n=16) just above half of the patients (56.3%) preferred to start exercising during treatment [42]. This suggests that patient finds it hard to commit to anything else during their medical treatment. Also, the majority of participants in both studies preferred to exercise at home as opposed to a hospital or community-based fitness center[42, 45]. In contrast to these findings, three feasibility studies conclude that it was feasible for patients with glioma to participate in exercising during treatment at the hospital if supervised by rehabilitation professionals [24, 40, 46]. Because of daily fluctuations in functioning, we find it important that patients have supervision from physical therapists to adjust the resistances and the degree of difficulty of balance exercises. At some sessions, our case wanted to cycle with intensities causing the workload pulse to exceed 75% of the heart rate reserve. Permission was granted as the therapist kept him under constant observation to prevent any dangerous consequences (heart arrest etc.) related to high-intensity training.

At follow-up, our case improved aerobe power (24%), muscle strength (0-38%), walking ability (9%), and standing balance (71%). This indicates that exercise rehabilitation can improve functional performance as previously reported [24, 40, 41, 43, 44]. He also improved ‘Global Health Status/QOL’ by 8.4 points and ‘Physical functioning’ by 6.7 points. Though it does not reach a delta score of ten points or more, which is considered to being clinically
relevant [47], it does indicate a potential difference from baseline, which is compelling to other studies[40, 41, 42, 43]. He also reported a decrease in ‘Social functioning’. This was likely related to a ban on driving, and to the medical treatment, as he had to travel to the hospital for 33 consecutive working days, which may have decreased his social activities. An interesting point in this report is fatigue. It is a frequently experienced symptom from cancer treatment modalities and affects more than 90% of the malignant glioma population [48]. Excessive fatigue may consequently lead to avoidance of social and physical activities to reduce discomfort. This may reinforce conditions of sedentary behaviour and reduced activity that further leads to reduced aerobe power, muscle wasting and impact QOL. Our case presented a stable symptom level of fatigue during the intervention course. This is interesting, as patients, in general, are expected to be increasingly affected by fatigue during the second part of irradiation treatment[49]. Strong methodological studies of various cancer populations have established that physical activity is effective in managing fatigue[50]. Despite no solid evidence in the literature of patients with glioma, our research group, in a study with limited sample size showed a statistically significant reduction of fatigue from exercise interventions[40].

“Take-away” lessons

The use of exercise as part of rehabilitation still needs attention in strong methodology studies of patients with gliomas. Here we have rationalized and developed an exercise rehabilitation intervention of a patient with GBM during active anticancer treatment to be used in such a study. Based on this single presented case, exercise rehabilitation has the ability to maintain or improve functional performance and QOL domains, even during a heavy treatment regime. It also implies that functional independent patients with GBM are capable, and may be willing
to participate in exercise rehabilitation at the hospital if supervised by physical therapists. The results, however impressive, cannot demonstrate causal effects as we cannot rule out the influence alleviating medical treatment, natural remission, or what other unknown factors as cognitive dysfunctions may have had on the results.

Acknowledgements

The authors wish to acknowledge the Region of Southern Denmark and the University of Southern Denmark, neuro-oncologist Dagmar Beier, physical therapist Line Marlev for assessing the patient, and Cathrine Lundgaard for guiding the case through the exercise program.

References


Outcomes were assessed at baseline (T1) and at conclusion of the six-week exercise intervention (T2)

Table 1 Balance exercises

<table>
<thead>
<tr>
<th>Exercise Type</th>
<th>Description and Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tilt Table</strong></td>
<td>Players try to direct a marble (or several depending on level) into a hole(s) by tilting the body left and right, or leaning forward and backwards. Players have 30 seconds to complete the game to enter the next level. The game focuses on weight shifting in mediolateral and anteroposterior directions, quick motor response ability and improvement of attention and coordination by visual feedback.</td>
</tr>
<tr>
<td><strong>Ski slalom</strong></td>
<td>Players try to ski down a slalom slope trying to navigate through gates by leaning left and right and leaning forward and backwards to control the pace. The game focuses on shifting weight in anteroposterior and mediolateral directions, changing and maintaining the position of the centre of gravity and improvement of attention and coordination by visual feedback.</td>
</tr>
<tr>
<td><strong>Ski jump</strong></td>
<td>Players try to jump as far as possible from a steep slope, standing in a position of flexed hips, knees and angles and rapidly extending at a precise moment holding the upraised position. The game focuses on quick motor response ability and improvement of attention and coordination by visual feedback.</td>
</tr>
<tr>
<td><strong>Physical therapist guided 'core stability' exercises on a Therapist Ball in a sitting position</strong></td>
<td>Maintain correct lumbar posture and balance while seated on the therapist ball. Sit with eyes closed. Spread your arms and alternately rotate the head to each side.</td>
</tr>
<tr>
<td><strong>Static sitting balance</strong></td>
<td>Flex and extend the trunk without moving forward or backwards. Flex and extend the lumbar part of the spine. Trunk Flexion Flex and extend the hips (with similar trunk movement) by leaning forward and backward. Laterally flex the trunk. Rotate the trunk.</td>
</tr>
<tr>
<td><strong>Weight shift</strong></td>
<td>Shift weight from one side to the other and lean forward and backward with small controlled rolling movements. Weight shift Reach destined objects by forward- and laterally flexing the trunk (rotating components was also included). The physical therapist gave perturbations in all directions.</td>
</tr>
</tbody>
</table>
Table 2 Training diary of the six-week exercise intervention

<table>
<thead>
<tr>
<th></th>
<th>Systolic BP mm/Hg</th>
<th>Diastolic BP mm/Hg</th>
<th>Warm-up + cycle (km)</th>
<th>Mean Pulse Hz</th>
<th>Pain during exercise (NRS)</th>
<th>Leg press (kg)</th>
<th>Knee extension (kg)</th>
<th>Knee flexion (kg)</th>
<th>Elbow flexion (kg)</th>
<th>Elbow extension (kg)</th>
<th>Wii fit plus games presented by Tilt table (highest points achieved)</th>
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<tr>
<td>T1</td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>Session 1 (12RM)</td>
<td>130</td>
<td>87</td>
<td>8.3</td>
<td>137</td>
<td>0</td>
<td>127.1</td>
<td>47.4</td>
<td>40.8</td>
<td>35.4</td>
<td>21.7</td>
<td>20</td>
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<tr>
<td>Session 2</td>
<td>138</td>
<td>84</td>
<td>9.8</td>
<td>142</td>
<td>0</td>
<td>127.1</td>
<td>47.4</td>
<td>40.8</td>
<td>31</td>
<td>21.7</td>
<td>20</td>
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<tr>
<td>Session 3</td>
<td>140</td>
<td>82</td>
<td>10.4</td>
<td>147</td>
<td>0</td>
<td>127.1</td>
<td>47.4</td>
<td>40.8</td>
<td>31</td>
<td>24.4</td>
<td>20</td>
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<tr>
<td>Session 4</td>
<td>134</td>
<td>76</td>
<td>10.8</td>
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<td>127.1</td>
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<td>40.8</td>
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<td>91</td>
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<td>153</td>
<td>0</td>
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<td>40.8</td>
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<td>24.4</td>
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<td>Session 6 (10RM)</td>
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<td>136.3</td>
<td>49.6</td>
<td>43.1</td>
<td>43.1</td>
<td>27.7</td>
<td>30</td>
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<td>Session 7</td>
<td>158</td>
<td>81</td>
<td>10.9</td>
<td>152</td>
<td>0</td>
<td>136.3</td>
<td>49.6</td>
<td>43.1</td>
<td>43.1</td>
<td>27.7</td>
<td>30</td>
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<tr>
<td>Session 8</td>
<td>158</td>
<td>84</td>
<td>11.9</td>
<td>155</td>
<td>0</td>
<td>136.3</td>
<td>49.6</td>
<td>43.1</td>
<td>43.1</td>
<td>27.7</td>
<td>30</td>
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<tr>
<td>Session 9</td>
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<td>11.1</td>
<td>150</td>
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<td>47.4</td>
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<td>43.1</td>
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<tr>
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<td>43.1</td>
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<td>87</td>
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<td>155</td>
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</tr>
</tbody>
</table>

The Numeric Pain Rating Scale 0-10: 0[none] 10[severe]
T1 (baseline assessment) T2 (six-week follow up)
RM (repetition maximum)
### Table 3 Functional Performance before and after the exercise the six-week exercise intervention

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight</strong></td>
<td>85.3</td>
<td>84.4</td>
</tr>
<tr>
<td><strong>Cardiorespiratory function</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerobe power (mLO².kg⁻¹.min⁻¹)</td>
<td>26.9</td>
<td>35.6</td>
</tr>
<tr>
<td><strong>Muscle strength 1RM (kg)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg press</td>
<td>203.1</td>
<td>225.2</td>
</tr>
<tr>
<td>Knee extension</td>
<td>74.8</td>
<td>101.3</td>
</tr>
<tr>
<td>Knee flexion</td>
<td>61.2</td>
<td>84.4</td>
</tr>
<tr>
<td>Elbow flexion</td>
<td>57.6</td>
<td>67.5</td>
</tr>
<tr>
<td>Elbow extension</td>
<td>36.6</td>
<td>36.6</td>
</tr>
<tr>
<td><strong>Walking ability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-meter walking test (m/s)*</td>
<td>1.46</td>
<td>1.59</td>
</tr>
<tr>
<td><strong>Balance measure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centre of pressure (cm²)*</td>
<td>6.21</td>
<td>1.83</td>
</tr>
</tbody>
</table>

*Average of three trials

T1 (baseline assessment) T2 (six-week follow up)

### Table 4 Quality of life before and after the six-week exercise intervention

<table>
<thead>
<tr>
<th>EORTC-QLQ-30</th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global Health Status/QoL</strong></td>
<td>66.6</td>
<td>75</td>
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<tr>
<td><strong>Functioning scales</strong></td>
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<tr>
<td>Physical functioning</td>
<td>86.6</td>
<td>93.3</td>
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<tr>
<td>Emotional functioning</td>
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<td>100</td>
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<tr>
<td>Role functioning</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Cognitive functioning</td>
<td>66.6</td>
<td>66.6</td>
</tr>
<tr>
<td>Social functioning</td>
<td>100</td>
<td>83.3</td>
</tr>
<tr>
<td><strong>Symptom scales/items</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td>22.2</td>
<td>22.0</td>
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<tr>
<td>Nausea and vomiting</td>
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<td>0</td>
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<tr>
<td>Pain</td>
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<td>0</td>
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<tr>
<td>Dyspnoea</td>
<td>33.3</td>
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<tr>
<td>Insomnia</td>
<td>33.3</td>
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<tr>
<td>Appetite loss</td>
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<td>0</td>
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<tr>
<td>Constipation</td>
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</tr>
<tr>
<td>Diarrhoea</td>
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<td>0</td>
</tr>
<tr>
<td>Financial difficulties</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

T1 (baseline assessment) T2 (six-week follow up)