REHABILITATION IN PRACTICE

Haemodynamic effects of physiotherapy programme in intensive care unit after liver transplantation

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Abstract

Objective. To determine the haemodynamic effects of intensive care physiotherapy after liver transplantation.

Patients and methods. Thirteen patients were included in the study after liver transplantation. The following physiotherapy programme were applied to the patients in intensive care unit: Respiratory physiotherapy, active joint movements, sitting in bed (first task), sitting at the edge of bed (second task), standing (third task), sitting out of bed (fourth task) and walking (fifth task). Heart rate (HR), mean, systolic and diastolic blood pressures (MBP, SBP, DBP), peripheral oxygen saturation (SpO2), respiration rate (RR) were recorded before treatment, after each task, after treatment and at the fifth minute of recovery. Pain level was assessed with Visual Analogue Scale (0–10).

Results. When compared with supine position before treatment, all of the parameters except RR increased after the first task whereas HR, SBP, MBP and pain increased after the second task. After the third task only HR and pain increased. There was no significant difference between the fourth task and pre-treatment values while HR, DBP and pain increased after the fifth task. When measurements of pre-treatment, immediately after treatment and the fifth minute of recovery were compared HR, MBP and pain increased after treatment whereas HR, RR and pain decreased after recovery. There was no significant difference between pre-treatment and fifth minute of recovery measurements.

Conclusion. Returning to initial values after a 5-min period shows that cardiopulmonary changes caused by intensive care physiotherapy after liver transplantation are responded at physiological limits.

Keywords: Liver transplantation, intensive care unit, physiotherapy

Introduction

Current literature is mainly interested in patients who had undergone liver transplantation in terms of fatigue, physical activity level, aerobic capacity, physical performance, muscle power and quality of life [1–3]. However, the number of studies concerning inpatient exercise programmes is limited [4–6].

According to Faenza et al. [7] muscle waste due to metabolic and nutritional deficits, peripheral neuropathies depending on postural components and respiratory complications require physiotherapy in intensive care unit after transplantation. Mor et al. [8] emphasised that early extubation, aggressive chest physiotherapy and early ambulation could shorten intensive care unit stay and prevent complications and mortality after liver transplantation.

In literature, most of the studies had examined different effects of exercise programmes in chronic period after liver transplantation [9–11]. Inpatient physiotherapy programme performed in the earliest period after liver transplantation belongs to Cortazzo et al. [12]. Since none of the studies were about the effects of intensive care physiotherapy programmes in liver transplant recipients, our study was planned to determine the cardiopulmonary effects of early period of physiotherapy in intensive care unit following liver transplantation.
Patients and methods

Thirteen liver transplant recipients older than 18 years old who were under post-surgical follow-up in Dokuz Eylul University, Department of Anesthesiology, Intensive Care Unit were enrolled in the study between March and September 2007. Inclusion criteria consisted of haemodynamic stability, spontaneous breathing, stable conscious state, haemoglobin level >7 g/dL. Patients with core temperature over 38°C, neurologic complication, arrhythmia, hypertension, tachycardia and musculoskeletal problem which limited exercising and those who did not accept to participate in the study were excluded. This study was performed with the approval of the local ethics committee of Dokuz Eylul University and informed consent was obtained from each patient (25.06.2007/240).

Assessment

Demographic data including age, gender, height, body weight, smoking and alcohol habits, former operations and family history were recorded. Primary liver disease, Child-Pugh classification and model for end-stage liver disease (MELD) score, diagnose time, history of hepatic encephalopathy, esophageal varices, variceal bleeding, pulmonary hypertension were recorded from the patients’ file. Operation data containing date, duration, anhepatic phase process were taken from intensive care unit files. American Society of Anesthesiologists (ASA) score, acute physiology and chronic health evaluation II (APACHE II) scores and ejection fraction were also recorded. While type and dose of immunosuppressive drugs were recorded from the files, total duration of intubation was calculated.

Data collection method

Haemodynamic parameters including heart rate (HR), mean, systolic and diastolic blood pressures (SBP/DBP/MBP) and respiratory parameters including peripheral oxygen saturation (SpO₂) and respiration rate (RR) were recorded from intensive care monitor (Draeger Medical Systems Inc, USA). All the parameters were recorded before treatment, after each task, at the moment when the patient was taken to bed and after 5 min of recovery. Pain intensity was assessed with Visual Analogue Scale in each task (0: no pain; 10: intensive pain).

Physiotherapy programme

At least 24 h later than the operation and after extubation, patients were taken into 5-graded physiotherapy programme. At the first task, apical, bilateral basal and diaphragmatic breathing exercises, holding breath at the maximum inhalation technique and coughing manoeuvre were applied. After respiratory physiotherapy was completed, controlled respiration in bed and active joint movements were performed. The number of exercises were changed around 5–10 according to the tolerance of patient. After that, cardiac position in bed (sitting at 45°) was performed. At the second task, the patient was made to sit at the edge of bed with support. 5–10 repetitive distal active joint movements were applied at this position. In order to prepare the patient to mobilisation, the surgical area was bandaged and drains, urine catheter, nasogastric catheter were fixed to his body with a plaster and oxygen tube and catheters were lengthened. Then, the patient was taken to standing position with the aid of physiotherapist (third task). At this position the patient took step forward and backward, to right and left. Alternately, the patient was taken to a chair near the bed (fourth task). Sitting time out of bed was determined according to patient’s tolerance. After sitting out of bed, the patient was taken away from the chair and ambulated with support, and the number of steps was recorded (fifth task). All the parameters were recorded at each task and the next step was applied in case there were no intolerance findings such as SpO₂ < % 90, 20 mmHg or more increase/decrease in SBP/DBP and 20 beats/min or more increase/decrease in HR, paradoxical breathing, dizziness, perspiration and faintness. Measurements were recorded again when the patient was taken back to supine position in bed after the whole treatment was completed. Recovery values were measured after 5 min without changing the position of the patient.

Statistical analyses

The Statistical Package for the Social Sciences (SPSS, Version 11.0, Chicago, IL) was used for data entry and statistical analyses. An α level of 0.05 was chosen as the level of statistical significance for all analyses. All p values were two-tailed. Wilcoxon’s signed rank test was used in the analyses of haemodynamic and respiratory parameters after each task. Parameters measured after each task were compared to the values of supine position. Friedman’s analysis of variance was used to determine the difference between pre-treatment, immediately after treatment and fifth minute of recovery measurements. Wilcoxon’s signed rank test was used to determine the significance level between these three measurements.
Results

Thirteen patients (seven female, six male), with a mean age of 44.4 ± 10.6 years, were able to complete all the five tasks of physiotherapy programme. Demographic characteristics of the subjects are shown in Table I. Primary liver diagnoses of the subjects are given in Table II. 61.5 % (n = 8) of the participants were living-donor liver transplant recipients whereas 38.5 % (n = 5) were cadaveric liver transplant recipients. Disease-specific findings are shown on Figure 1. Eight subjects were non-smokers; three quitted smoking 2–5 years ago; one quitted smoking 10 days before the operation date; one was a current smoker. Twelve had no habit of drinking alcohol, and one quitted drinking 4 months ago prior to the operation. All the patients took Prograf as immunosuppressive medication.

Mean sitting duration in bed was 9.1 ± 3.1 min; mean duration of sitting at the edge of the bed was 6.2 ± 8.3 min and mean duration of sitting out of bed on the chair was 25.5 ± 14.2 min. Mean walking distance was 6.6 ± 3.3 steps. All the measurements recorded after each task were compared to pre-treatment supine position values. The differences between pre-treatment measurements and each task are shown in Table III.

According to Friedman’s analysis of variance, significant differences were found in HR, MBP, RR and pain intensity between pre-treatment, immediately after treatment and recovery measurements (p < 0.05). Table IV shows the comparison of HR, MBP, RR and pain intensity measurements between pre-treatment, immediately after treatment and fifth minute of recovery period.

Discussion

All the liver transplant patients included in our study were able to participate in five-graded physiotherapy programme in intensive care unit without any deterioration in their clinical status. Even though our physiotherapy programme resulted in significant differences in some respiratory and haemodynamic parameters after the tasks, all measurements were close to pre-treatment values after 5 min of recovery when the patient was taken back to lying position in bed.

In our study, first task referred to sitting in bed, respiratory physiotherapy and active joint movements. All the parameters except RR increased after the first task. Since respiratory physiotherapy is an important part of the post-operative physiotherapy for patients with abdominal surgery, we added this physiotherapy application to the first mobility task [13–15]. Respiratory physiotherapy is also vital in ICU and its effect on haemodynamic and respiratory parameters has been investigated before [16,17]. Klein et al. [16] examined the effect of chest physiotherapy on haemodynamic responses on 23 mechanically ventilated intensive care patients with abdominal and thoracic surgery and found that HR, SBP, MBP; cardiac output, oxygen consumption and carbon dioxide production had increased during respiratory physiotherapy. Weissman et al. [17] investigated the change in metabolic and haemodynamic parameters as a result of routine intensive care activities of 23 mechanically ventilated patients and found that respiratory physiotherapy led...
to a higher increase in HR, SBP, double product, oxygen consumption and carbon dioxide production than usual intensive care activities such as extremity movements and physical examination. In our study, similar to Klein’s and Weissman’s findings, increases in cardiopulmonary parameters were found after the first task including respiratory physiotherapy, active joint movements and sitting in bed.

During sitting at the edge of bed as the second task, significant increases were found in HR, SBP, MBP and pain intensity compared with pre-treatment supine position. Zafiropoulos et al. [18] investigated the physiological responses of the intubated subjects with abdominal surgery to early mobilisation and they found significant increases in SBP, DBP and MBP as a result of sitting at the edge of bed. Similarly, Stiller et al. [19] found significant increases in HR, SBP and DBP as a result of sitting at the edge of bed in their medical, surgical and traumatic critically ill patients. Our results of sitting at the edge of bed were parallel to the findings of Stiller and Zafiropoulos.

Our third task was standing near the bed and we found significant increases in HR and pain intensity. Similarly, Zafiropoulos et al. [18] and Stiller et al. [19] found an increase in HR during standing. Nevertheless, Zafiropoulos et al. [18] pointed out an increase in RR during standing differently from our study. As the subjects participated in that study were intubated and mechanically ventilated, this increase in RR might be associated with patients’ attempts to make up for the increased work of spontaneous breathing due to standing through an endotracheal tube without ventilatory support. However, none of our subjects were intubated and mechanically ventilated.

In our study in which we measured the mean sitting duration outside the bed as 25.5 min, we did not find a significant difference between pre-treatment measurements and values recorded after sitting on a chair. We consider that the absence of significant difference between pre-treatment values and fourth task is due to the average time spent on sitting out of bed which was enough for

### Table III. The comparison of treatment tasks with pre-treatment values.

<table>
<thead>
<tr>
<th>n = 13</th>
<th>Pre-treatment, mean ± SD</th>
<th>First task, mean ± SD</th>
<th>Second task, mean ± SD</th>
<th>Third task, mean ± SD</th>
<th>Fourth task, mean ± SD</th>
<th>Fifth task, mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR (beat/min)</td>
<td>78.0 ± 17.2</td>
<td>83.5 ± 19.8*</td>
<td>81.2 ± 18.5*</td>
<td>85.4 ± 18.3*</td>
<td>79.8 ± 15.8</td>
<td>86.4 ± 17.8*</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>126.7 ± 16.3</td>
<td>137.7 ± 19.0*</td>
<td>131.4 ± 15.8*</td>
<td>128.7 ± 19.0</td>
<td>129.5 ± 15.2</td>
<td>130.2 ± 12.7</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>69.0 ± 9.9</td>
<td>74.2 ± 11.5*</td>
<td>72.2 ± 12.0</td>
<td>71.0 ± 9.0</td>
<td>70.5 ± 8.4</td>
<td>73.8 ± 10.2*</td>
</tr>
<tr>
<td>MBP (mmHg)</td>
<td>88.5 ± 12.7</td>
<td>94.1 ± 13.7*</td>
<td>93.9 ± 12.4*</td>
<td>92.5 ± 17.1</td>
<td>93.7 ± 9.4</td>
<td>93.5 ± 12.2</td>
</tr>
<tr>
<td>RR (breath/min)</td>
<td>22.6 ± 5.0</td>
<td>22.6 ± 5.1</td>
<td>23.1 ± 6.4</td>
<td>24.3 ± 6.2</td>
<td>23.4 ± 5.5</td>
<td>23.5 ± 4.7</td>
</tr>
<tr>
<td>SpO2 (%)</td>
<td>98.3 ± 2.1</td>
<td>99.0 ± 1.6*</td>
<td>97.9 ± 2.0</td>
<td>97.4 ± 2.3</td>
<td>98.5 ± 1.3</td>
<td>98.3 ± 1.8</td>
</tr>
<tr>
<td>Pain severity</td>
<td>5.0 ± 3.0</td>
<td>2.0 ± 2.7*</td>
<td>6.2 ± 2.0*</td>
<td>4.9 ± 1.9*</td>
<td>4.4 ± 2.6</td>
<td>6.0 ± 1.8*</td>
</tr>
</tbody>
</table>

HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; MBP, mean blood pressure; RR, respiration rate; SpO2, peripheral oxygen saturation.

* p < 0.05, Wilcoxon’s signed rank test.

### Table IV. The comparison of pre-treatment, immediately after treatment and 5 min of recovery period measurements.

<table>
<thead>
<tr>
<th>n = 13</th>
<th>Pre-treatment, mean ± SD</th>
<th>Immediately after treatment, mean ± SD</th>
<th>5 min recovery, mean ± SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR (beat/min)</td>
<td>78.0 ± 17.2</td>
<td>84.9 ± 18.0</td>
<td>0.003*</td>
<td></td>
</tr>
<tr>
<td>MBP (mmHg)</td>
<td>88.5 ± 12.7</td>
<td>96.5 ± 11.9</td>
<td>0.02*</td>
<td></td>
</tr>
<tr>
<td>RR (breath/min)</td>
<td>22.6 ± 5.0</td>
<td>25.8 ± 7.0</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>Pain severity</td>
<td>5.0 ± 3.0</td>
<td>6.0 ± 1.9</td>
<td>0.007*</td>
<td></td>
</tr>
<tr>
<td>n = 13</td>
<td>Immediately after treatment, mean ± SD</td>
<td>5 min recovery, mean ± SD</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>HR (beat/min)</td>
<td>84.9 ± 18.0</td>
<td>78.2 ± 16.7</td>
<td>0.002*</td>
<td></td>
</tr>
<tr>
<td>MBP (mmHg)</td>
<td>96.5 ± 11.9</td>
<td>92.8 ± 13.2</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>RR (breath/min)</td>
<td>25.8 ± 7.0</td>
<td>22.3 ± 5.4</td>
<td>0.02*</td>
<td></td>
</tr>
<tr>
<td>Pain severity</td>
<td>6.0 ± 1.9</td>
<td>3.8 ± 2.4</td>
<td>0.02*</td>
<td></td>
</tr>
<tr>
<td>n = 13</td>
<td>Pre-treatment, mean ± SD</td>
<td>5 min recovery, mean ± SD</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>HR (beat/min)</td>
<td>78.0 ± 17.2</td>
<td>78.2 ± 16.7</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>MBP (mmHg)</td>
<td>88.5 ± 12.7</td>
<td>92.8 ± 13.2</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>RR (breath/min)</td>
<td>22.6 ± 5.0</td>
<td>22.3 ± 5.4</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>Pain severity</td>
<td>5.0 ± 3.0</td>
<td>3.7 ± 2.4</td>
<td>0.61</td>
<td></td>
</tr>
</tbody>
</table>
cardiopulmonary responses to recover. After walking which was the last mobility task of our programme HR, DBP and pain intensity increased significantly. Similar to standing position, increase in the intensity of pain was accompanied by an increase in HR. This made us think that HR response might be due to pain rise. In the study of Stiller et al. [19], since only one subject managed to walk, the data related to walking was not included. Orfanos et al. [20] investigated the effects of deep breathing exercises and ambulation on ventilatory pattern after upper abdominal surgery and found that ambulation led to a non-significant increase in tidal volume and respiratory rate. Similar to Orfanos’s findings an increase in RR was found in our study after walking in comparison to previous task but not to pre-treatment values This increase can be attributed to the increase in oxygen need due to walking activity and increased sympathetic system activation related to pain. Although all the subjects in Zafropoulos’ study and 38.7% of the subjects in Stiller’s study were post-surgical, none of the researchers assessed pain intensity during mobilisation. However, it is known that pain may lead to an increase in haemodynamic parameters such as HR and blood pressure by increasing sympathetic stress response [21–23].

There are several outcome studies investigating physical activity level, aerobic capacity, muscle strength and quality of life after liver transplantation [1–3]. However, there is not sufficient and satisfactory data on the rehabilitation course of this population. To our knowledge, this is the first study related to early post-operative physiotherapy programme of liver transplant recipients applied in intensive care unit. Although there are two published articles investigating the effects of early physiotherapy programme after liver transplantation, both of them were carried out in inpatient settings not in intensive care conditions [24–25]. Beyer et al. [24] applied early mobilisation to 38 liver transplant patients in post-operative first 3 weeks and daily exercise programme with an increasing intensity. After the third week, they practiced group exercise programme consisting of warming up, strengthening, balance, flexibility and aerobic exercises. After discharge, patients were enrolled into an 8–24 month exercise programme, as 1 h in 2 weeks. As the result increases in aerobic capacity, muscle strength and physical performance were determined [24]. In the other study, Cortazzo et al. [12] retrospectively examined the records of 55 liver transplant patients in acute inpatient rehabilitation unit after the operation. They found significant increases in functional independency scores and their most patients were discharged directly to home after acute rehabilitation. Nevertheless, they did not mention the details and content of their acute rehabilitation course.

The most important limitation of our study was the number of cases. We think that larger numbers of participants may affect the results. With our small group, we did not observe any significant differences between pre-treatment haemodynamic and respiratory parameters and recovery measurements. As a result, we consider that early post-operative physiotherapy programme including respiratory physiotherapy and mobilisation is feasible for liver transplant patients in intensive care unit. This programme can be standardised for transplant patients. Although it has been already shown that physiotherapy in intensive care units leads to beneficial results among different patient groups [18,19,25,26] it is still not obviously known whether physiotherapy in intensive care unit have an effect on the length of intensive care unit and hospital stays and intensive care unit complications after liver transplantation. Therefore, further randomised-controlled studies with larger number of cases are necessary to provide new clinical sight to intensive care physiotherapy after liver transplantation.

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References


