Recovery Pattern in Different Surgical Approaches on Thoracic Enhanced Recovery based Fourteen-Step Protocol in Patients Undergoing Cardio-thoracic Surgery at University Hospital of Nepal

Karmacharya RM, Shakya R, Singh AK, Baidya S, Dahal S, Dhakal P, Shrestha P, Bhandari N

1Department of Surgery (Cardio Thoracic and Vascular), Dhulikhel Hospital, Kathmandu University Hospital Kathmandu University School of Medical Sciences Dhulikhel, Kavre, Nepal.

2Department of Physiotherapy, Dhulikhel Hospital, Kathmandu University Hospital Kathmandu University School of Medical Sciences Dhulikhel, Kavre, Nepal.

Corresponding Author
Robin Man Karmacharya
Department of Surgery (Cardio Thoracic and Vascular), Dhulikhel Hospital, Kathmandu University Hospital Kathmandu University School of Medical Sciences Dhulikhel, Kavre, Nepal.
E-mail: reachrobin773@hotmail.com

ABSTRACT

Background
Cardio-thoracic surgery involves open and minimally invasive techniques. Enhanced recovery after surgery is used for early recovery from surgery. Enhanced recovery after surgery decreases hospital stay duration. Patients undergoing Enhanced recovery after surgery after video assisted thoracic surgery use less pain killers and have less hospital cost. There has not been any study on outcomes on patient who follow physiotherapy protocol designed in our setting.

Objective
To find the physiotherapy outcomes in patients undergoing thoracic enhanced recovery after surgery (T-ERAS) based 14 step protocol locally designed at Dhulikhel Hospital, Kathmandu University Hospital (DH, KUH).

Method
This is a retrospective cross sectional observational study. All the cases who underwent cardiothoracic surgery were classified based on the approach of chest surgery performed into groups Sternotomy, Thoracotomy and Video Assisted Thoracic Surgery (VATS) groups. Patients were advised for Thoracic Enhanced recovery after surgery based on the protocol that has been devised at Dhulikhel Hospital. The recovery of patients based on activities they could perform was noted and analyzed.

Result
Both ICU stay and hospital stay in number of days were highest in thoracotomy (6.04 days) group while that was lowest in video assisted thoracic surgery group (1.67 days). There is a similar recovery until step 5, i.e. 2 days and rapid progression in further steps in video assisted thoracic surgery group while it is much slower in both sternotomy and thoracotomy groups.

Conclusion
Postoperative mobilization and physiotherapy enhance early healing and decrease hospital stay. Mean hospital stay and ICU stay were shorter for video assisted thoracic surgery cases compared to Thoracotomy and Sternotomy groups and the mean days to achieve different steps varied within the protocol between groups compared.

KEY WORDS
Cardio-thoracic surgery, Physiotherapy, Protocol, Sternotomy, Thoracic enhanced recovery after surgery, Thoracotomy, Video assisted thoracic surgery
INTRODUCTION
Cardio-thoracic surgery involves open and minimally invasive surgery of heart and lung using surgical approaches like Video Assisted Thoracoscopic Surgery, Sternotomy, Minithoracotomy and Thoracotomy.1 Cardiac surgery can range from open and closed heart surgery for a variety of cardiac anomalies. Thoracic surgery commonly performed are decortication for empyema, pleural biopsy, pleurodesis, lobectomy, pneumonectomy etc. The morbidity to surgery varies between the open and minimally invasive surgery where the surgery related trauma and morbidity is higher for open surgery.2

Application of perioperative protocols known as Enhanced recovery after surgery (ERAS) protocols uses early mobilization during postoperative period for early recovery after surgery. This approach when applied to patients who went lung cancer surgery were found to have significantly lower morbidity rate.3 Several studies done showing the use of thoracic enhanced recovery protocols of their own have shown improvement in outcomes like length of stay, complications rate or readmission rate.3-5 The patients undergoing ERAS after Video Assisted Thoracic Surgery (VATS) VATS showed significant reduction of postoperative morphine equivalents, total fluid balance and mean inflation adjusted hospital cost.5

In this study, we tested the outcomes such as ICU admission days, ventilator in patients undergoing Thoracic Enhanced Recovery After Surgery (T-ERAS) based protocol locally designed at Dhulikhel Hospital, Kathmandu University Hospital (DH, KUTH). The aim of this protocol is to adhere to early physiotherapy and mobilization following cardio thoracic surgery.

METHODS
We did a retrospective study taking data from Dhulikhel Hospital patient records. We included all the cases who underwent cardiothoracic surgery and were admitted to the ICU at Dhulikhel Hospital, Department of Surgery during January 2016 to December 2018. We classified the cases on the basis of the approach of chest surgery performed into groups Sternotomy, Thoracotomy and Video assisted thoracic surgery (VATS). If VATS cases were converted to thoracotomy we included them in the thoracotomy group. In Sternotomy, midline incision is given and full sternotomy is done. For thoracotomy, intercostal incision is longer than 5 cm and rib spreader is used. While in case of VATS, all intercostal incisions are smaller than 5 cm and laparoscopic instruments are used. During analysis we included cases done by VATS as minimally invasive and that by Thoracotomy and Sternotomy as invasive surgical technique.

All eligible patients were advised for T-ERAS based on the protocol that has been devised at Dhulikhel Hospital. The protocol included preoperative chest physiotherapy for a week, smoking cessation for two weeks prior to surgery and 14 steps postoperative physiotherapy protocol (Table 1). The patient is advised progress on this fourteen steps as much as possible and the days taken to attain the different steps were noted as soon as the patient is able to perform them.

The hospital record data was analyzed using Statistical Package for the Social Sciences (SPSS) 20.0.

Table 1. Fourteen step protocol

<table>
<thead>
<tr>
<th>Steps</th>
<th>Activities</th>
<th>Date achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Passive Range of motion (ROM), active ankle exercise, self feeding, sitting on bed.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Same+Lung expansion exercise (deep breathing+deep diaphragmatic+segmental breathing), Incentive Spirometer, Dangling of legs at the side of bed</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Same+active assisted ROM sitting in bed (arm flexion), moving within bed with splinting. Transfer to chair, Standing with marching on spot.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Same+Minimal resistance ROM, arm flexion upto full ROM, sit ups, increased sitting time, transfer to chair twice daily.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Same+Moderate resistance ROM exercise upto full ROM, sit ups and lunges</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Same+standing and regular activities, trunk extension, walking to bathroom</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Same + standing aerobic exercise; Walking 10 feet at comfortable pace with pacing</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Same + increased ambulation (hall ambulation 30 feet / as tolerated 3-4 times/day)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Increase program, energy conservation. Walk downstairs and use elevators for going up.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Walking with light weight - increased walking distance</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Increase duration of each activity, teach self monitoring with pulse rate, walking distance 70 feet.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Resistance exercise for limbs Walking downstairs to 2 flights</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Independent hall ambulation 100 feet.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Walk up 1 flight of stairs up and down</td>
<td></td>
</tr>
</tbody>
</table>

RESULTS
There were 48 patients during the time frame. Of these, 33 (68.8%) were male and 15 (31.2%) were female. Of these, 26 (54.17%) underwent thoracotomy, 12(25%) underwent VATS while 10 (20.83%) had surgery by sternotomy approach (Table 2).

Table 3 shows mean ICU stay and hospital admission days in different surgical approaches. Both ICU stay and hospital stay were highest in thoracotomy group and lowest in VATS group.
The findings were statistically significant (p < 0.05) in both ICU stay and Hospital stay. For post hoc tests in ICU stay, it was significantly higher in thoracotomy vs VATS and Sternotomy vs VATS. In hospital stay, no significant difference between the two groups was noted on post hoc tests.

Figure 1 shows mean days required to attain consecutive steps from 14 step protocol in the three approaches. In all the groups, mean days required is within two days till step 5. Then after step 6 there is rapid progress to further steps for VATS group while it is much slower for sternotomy and thoracotomy groups.

In figure 2, similar graph is drawn but the groups thoracotomy and sternotomy are mixed as invasive approach and VATS kept as minimally invasive approach. The rapid progression from step 6 can be seen here as well.

Figure 3 shows Kaplan Meier Curves for invasive and minimally invasive approach for reaching steps 8 to 11. The gaps in the curve of two approaches in step 8 and step 9-11 can be noted. Figure 4 shows the curve for reaching step 14. After day 4 there is much difference in proportion of cases reaching step 14. The p value between two curves was less than 0.01.

In table 4, mean days taken to attain different steps between minimally invasive and invasive approaches are shown. Statistical significance (p < 0.05) can be noted in step 3, 6, 7, 10 to 14. The mean number of days taken to reach step 1 to 5 (except step 3) is not significantly different in two approaches but there is significantly different in most of the steps from step 6 onwards. There is lesser days taken to attain the steps in minimally invasive approach in all the steps except step 5. An important “big jump” in the days taken can be noted in step 6 of invasive approach in which there is 2.58 days in step 6 while 1.64 in step 5 (marked bold in the table).

Table 2. Number and percentage of cases in different surgical approaches.

<table>
<thead>
<tr>
<th>Approach</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracotomy</td>
<td>26</td>
<td>54.17</td>
</tr>
<tr>
<td>Sternotomy</td>
<td>10</td>
<td>20.83</td>
</tr>
<tr>
<td>VATS</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3. Mean ICU stay days and hospital admission days in different surgical approaches.

<table>
<thead>
<tr>
<th>Approach</th>
<th>ICU Stay</th>
<th>Hospital Stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracotomy</td>
<td>6.04</td>
<td>11.38</td>
</tr>
<tr>
<td>Sternotomy</td>
<td>5</td>
<td>7.4</td>
</tr>
<tr>
<td>VATS</td>
<td>1.67</td>
<td>5.83</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>100</td>
</tr>
</tbody>
</table>

Figure 1. Mean days required to attain different steps in 14 step protocol in different approaches

Figure 2. Mean days taken to attain different steps in minimally invasive and invasive approaches

Figure 3. Kaplan-Meier Survival Curve for 8th to 11th Step

Figure 4. Kaplan Meier Curves for steps 14
DISCUSSION

Many surgical techniques for thorax surgery have been developed from large incisions, keyhole approaches to robotic surgical approach. For cardiac surgeries, minimally invasive techniques like minithoracotomy, hemisternotomy are getting popular compared to standard sternotomy technique. For lung’s surgery, shift is from posterolateral incisions, muscle sparing thoracotomy to VATS. Now keyhole surgeries for thorax have developed as single port VATS and Robot assisted thoracoscopic surgery (RATS). Newer approach includes subxiphoid approach for thorax surgeries. These minimally invasive techniques help in quicker recovery and less hospital stay of patients which match our findings.

ERAS protocol is set to increase the quality of recovery of patients and duration of hospital stay after surgery. In postoperative management, early mobilization within 24 hours and physiotherapy are essential tools for faster recovery. Inability to mobilize early delays discharge of patients. Physiotherapy helps in recovery from postoperative respiratory insufficiency, improves respiratory function and prevents complications like atelectasis, pneumonia, empyema and Deep Vein Thrombosis. Pulmonary physiotherapy before and after thoracic surgery improves exercise capacity and quality of life. Postoperative physiotherapist supervised physical activity improves postoperative functional capacity and reduces the length of hospital stay.

There are many locally followed physiotherapy protocols chiefly focusing on pulmonary physiotherapy and mobilization for post cardio thoracic surgery cases. Hourly deep breathing exercises with or without a Positive Expiratory Pressure (PEP), deep breathing exercises, coughing techniques, chest wall vibrations and mobilization focused on the initial five postoperative days with one to six treatment sessions per day, mobilization done from sitting to standing or positioning to sides, bilateral upper extremity exercises are done in different places. A program comparison showed no difference between expiratory and inspiratory stimulating techniques applying early mobilization in both groups for cardiac rehabilitation. We developed a physiotherapy protocol for recovery after cardiothoracic surgery which includes patients achieving various steps of physiotherapy.

In our protocol, pulmonary physiotherapy along with passive progression to active mobilization was divided into 14 steps with endpoint of patient being able to walk a flight of stairs up and down. Early sitting position and mobilization (walking within four hours) leads to better recovery compared to that done on the next day. A seven step protocol was used to assess the evolution of physical therapy in patients after cardiac surgery until hospital discharge. Pulmonary physiotherapy including deep diaphragmatic exercises and incentive spirometry were similar to ours. In a study from India, pulmonary rehabilitation and range of motion exercise of extremities were done in cases recovering from thoracic surgery from day one which is similar to our protocol. Dangling of lower limbs over edge of the bed was done in day one, walking up to chair and sit to stand exercises in day two and staircase climbing by day four. In our study, we noted differences in minimally invasive and invasive approaches after step 6. As walking is commenced from step 6, postoperative pain in invasive approach might have limited progression from this step onwards. 39.9% patient could do ambulation by second postoperative day following cardiac surgery. VATS lobectomy developed less pulmonary complications and were mobile earlier than thoracotomy lobectomy. Wenger protocol devised a 14 steps protocol for cardiac rehabilitation in post myocardial infarction cases focusing on mobilization, ambulation is started in 2-3 days. They haven’t mentioned pulmonary physiotherapy in their work.

We could not find relevant similar physiotherapy protocol in our context. We could not find adequate literature comparing outcomes in different approaches of cardiothoracic surgery relating to postoperative physiotherapy goals.

CONCLUSION

Postoperative mobilization and physiotherapy enhance early healing and decrease hospital stay. Mean hospital stay and ICU stay were shorter for VATS cases compared to Thoracotomy and Sternotomy groups. The mean days to achieve different steps varied within the protocol with steps 3,6,7,10-14 being earlier in minimally invasive group.
compared to invasive group. In step 14, the proportion of cases where this step is attained in groups minimally invasive and invasive is similar till 4th day after which there is huge gap in two groups with longer duration for invasive group.

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REFERENCES


