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Best evidence topic - Thoracic oncologic

Is preoperative physiotherapy/pulmonary rehabilitation beneficial in lung resection patients?

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Summary

A best evidence topic in thoracic surgery was written according to a structured protocol. The question addressed was whether preoperative physiotherapy/pulmonary rehabilitation is beneficial for patients undergoing lung resection. Ten papers were identified using the reported search, of which five represented the best evidence to answer the clinical question. In 2007 a report showed in 13 subjects receiving a preoperative rehabilitation programme (PRP) an improvement of maximum oxygen uptake consumption (VO_2 max) of an average 2.4 ml/kg/min (95% confidence interval 1–3.8; $P=0.002$). A report in 2008 showed in 12 patients with chronic obstructive pulmonary disease (COPD) and VO_2 max <15 ml/kg/min that PRP could effect a mean improvement in VO_2 max of 2.8 ml/kg/min ($P<0.001$). An earlier report in 2005 demonstrated a reduced length of hospital stay (21±7 days vs. 29±9 days; $P=0.0003$) in 22 subjects who underwent PRP for two weeks compared with a historical control of 60 patients with COPD. It was shown in 2006 that by using a cross-sectional design with historical controls that one day of chest physiotherapy comprising inspiratory and peripheral muscle training compared with routine nursing care was associated with a lower atelectasis rate (2% vs. 7.7%) and a median length of stay that was 5.73 days vs. 8.33 days ($P<0.0001$). A prospective randomised controlled study in 1997, showed that two weeks of PRP followed by two months of postoperative rehabilitation produced a better predicted postoperative forced expiratory volume in one second in the study group than in the control group at three months (lobectomy +570 ml vs. −70 ml; pneumonectomy +680 ml vs. −110 ml). We conclude that preoperative physiotherapy improves exercise capacity and preserves pulmonary function following surgery. Whether these benefits translate into a reduction in postoperative pulmonary complication is uncertain.

Keywords: Lung resection; Preoperative physiotherapy

1. Introduction

A best evidence topic was constructed according to a structured protocol. This is fully described in the ICVTS [1].

2. Three-part question

In [patients undergoing lung resection] is [preoperative physiotherapy/rehabilitation] of benefit in [improving preoperative exercise capacity, postoperative pulmonary complications (PPC) and length of stay (LOS)?]

3. Clinical scenario

A 65-year-old smoker with a resectable right lower lobe T1 lung cancer is deemed borderline for resection, with a forced expiratory volume in one second (FEV_1) <30% and poor exercise capacity. Preoperative physiotherapy/pulmonary rehabilitation improves exercise tolerance in patients with chronic obstructive pulmonary disease (COPD), so we reviewed the literature to evaluate whether this strategy improves exercise capacity and outcomes in patients undergoing lung resection.

4. Search strategy

Medline and Embase were searched from 1950, and Cinahl from 1980 to November 2010. Search terms were: [preoperative physiotherapy. lung resection]. The Cochrane Library was also searched using these terms. A hand search was used to follow-up references.

5. Search outcome

Twenty-five references were identified from Medline, 15 from Embase and none from Cinahl. Three references were found in the Cochrane Library. After removing cross-references and non-English language papers, 10 were selected, of which a further four (three reviews and one protocol description) were excluded, leaving six as giving the best evidence on the topic (Table 1).

6. Discussion

Cesario et al. [2] published a pilot trial comprising eight patients who underwent an inpatient preoperative rehabil-

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Table 1. Best evidence papers

Author, date and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Cesario et al., (2007), Lung Cancer, Italy, [2] Pilot trial (level 2b)	n=8 Lung cancer Surgeon's selection Four-week inpatient PRP	Exercise capacity 8/8	FVC increased by 0.44 l (volume), 12.9% (% predicted) 6MWD improved by 47.4% ($P<0.05$) PaO_2 improved by 7.2 mmHg ($P<0.01$)	Cost implications of an inpatient PRP not defined
Jones et al., (2007), Cancer, USA, [3] Feasibility study (level 2b)	n=18 Lung cancer Surgeon's selection Three-week cycle (×five/week)	Exercise capacity 13/18	VO_2 max increased by 2.4 ml/kg/min (95% CI 1.0–3.8; P=0.002) 6MWD improved by 40 m (95% CI 16–64; P=0.003)	Selection criteria not clear Five patients dropped out; reasons not stated
Bobbio et al., (2008), Eur J Cardiothorac Surg, Spain, [4] Feasibility study (level 2b)	n=12 Lung cancer COPD VO_2 max < 15 ml/kg/min Four-week IMT (IS)+ PMT (×five/week)	Exercise capacity 11/12	VO_2 max increased by 2.8 ml/kg/min (13.5±1.3 vs. 16.3±1.9 ml/kg/min; $P<0.001$)	No mortality but PPC rate is 8/11 (73%) Programme delayed surgical intervention
Sekine et al., (2005), Jpn J Thorac Cardiovasc Surg, Japan, [5] Historic case control study (level 2b)	n=22 (2005) vs. 60 (1995–1999) Lung cancer COPD Two-week IMT (IS)+ PMT (5000 steps) (×five/week)	PPO FEV_1 LOS rehabilitation vs. control	Actual:predicted ratio of FEV_1 was better in rehabilitation (P=0.047) 29±9 vs. 21±7 days (P=0.0003)	FEV_1 and FEV_1/FVC ratio lower in rehabilitation group ($P<0.05$) LOS long in both groups
Varela et al., (2006), Eur J Cardiothorac Surg, Spain, [6] Historic case control study (level 2b)	n=119 (2002–2004) vs. 520 (1994–2002) One day IMT (IS)+ PMT vs. IS alone	Atelectasis LOS PPO FEV_1	IMT (IS)+PMT vs. IS alone 2% vs. 7.7% (OR 0.2, 95% CI 0.05–0.86) 5.73 vs. 8.33 ($P<0.001$) 69% (±16) vs. 70 (±17) (P=0.04)	VATS rate higher in intervention group
Weiner et al., (1997), J Thorac Cardiovasc Surg, Israel, [7] Prospective randomised control trial (level 1b)	n=32 Lung cancer COPD Preoperative two-week IMT (IS) (×six/week) vs. no training Postoperative 12-week	PPC rate PPO FEV_1 at three months	IS and IMT vs. no training 2/17 vs. 2/15 Lobectomy +570 ml vs. –70 ml Pneumonectomy +680 ml vs. –110 ml	No difference in PPC rate

6MWD, six-minute walking distance; CI, confidence interval; COPD, chronic obstructive pulmonary disease; FEV_1, forced expiratory volume in one second; FVC, forced vital capacity; IMT, inspiratory muscle training; IS, inspiratory spirometry; LOS, length of stay; OR, odds ratio; PaO_2, partial pressure of oxygen in arterial blood; PMT, peripheral muscle training; PPC, postoperative pulmonary complications; PPO FEV_1, predicted postoperative forced expiratory volume in one second; PRP, preoperative rehabilitation programme; VATS, video-assisted thoracoscopic surgery; VO_2 max, maximum oxygen uptake consumption under strenuous exercise.

itation programme (PRP). Patients were selected at the surgeon's discretion. Exercise comprised five daily sessions of three hours each, every week, of supervised incremental exercise cycling and treadmill at 80% maximal workload for the extremities, breathing exercises, functional electrical stimulation of the abdominal muscles and educational sessions. This was evaluated with a six-minute walking distance (6MWD). Significant improvement was observed in forced vital capacity (FVC) (volume 0.44 l and percentage of predicted by 12.9%). 6MWD improved by 47% ($P<0.05$) and partial pressure of oxygen in arterial blood by 7.2 mmHg (12.4%; $P<0.01$). This demonstrates the physiological benefit of a structured preoperative exercise programme.

Jones et al. [3] published a feasibility study including 18 subjects receiving structured exercise training until surgical resection. Patients were selected at the surgeon's discretion but were excluded if the FEV_1 was below 1.1 l and/or

the diffusion capacity of carbon monoxide was <70% predicted. Exercise comprised five endurance cycle sessions per week for three weeks, gradually increasing the workload. Thirteen subjects were assessed after surgery. Preoperative VO_2 max improved by an average of 2.4 ml/kg/min (95% CI 1–3.8; $P=0.002$) and 6MWD by 40 m (95% CI 16–64; $P=0.006$). This proves that PRP can improve exercise capacity in patients prior to major thoracic surgery.

Bobbio et al. [4] performed a prospective observational study of patients with COPD and demonstrated a significant improvement in maximum oxygen uptake consumption (VO_2 max). COPD was defined as $FEV_1/FVC<0.7$ and $FEV_1<70\%$ predicted. Twelve subjects with staged I/II non-small cell lung cancer with VO_2 max<15 ml/kg/min were recruited into a PRP comprising 90-minute sessions five days a week for four weeks that incorporated supervised breathing exercises, cough techniques, incentive spirometry (IS) and peripheral muscle training. In the 11 subjects who underwent surgery, there was a mean improvement in VO_2 max of 2.8 ml/kg/min (13.5±1.3 ml/kg/min vs. 16.3±1.9 ml/kg/min; $P<0.001$). Eight of the 11 subjects developed a PPC. Two developed atelectasis that resolved with physiotherapy. Six underwent bronchoscopy; four of these had a mini-tracheostomy for sputum retention, and one was admitted to the intensive therapy unit for ventilation due to respiratory insufficiency. This proves that PRP improves exercise capacity despite an absence of changes in the resting FEV_1/FVC ratio.

Sekine et al. [5] compared 22 subjects with COPD who had undergone rehabilitation prior to surgery with 60 historical controls. Patients with clinically and radiologically defined COPD underwent a PRP for two weeks; this consisted of IS, breathing and cough exercises with bronchodilator nebulisers (five times a day) and exercise (walking >5000 steps per day). This exercise was continued until hospital admission and postoperatively until discharge. Postoperatively, the 22 subjects had a 'chest squeeze' performed after bronchodilators by physiotherapists or doctors. The control group had only chest physiotherapy in the postoperative period. Despite a lower FEV_1/FVC ratio ($P<0.05$), the LOS was shorter in the rehabilitation group (21±7 days vs. 29±9 days; $P=0.0003$), but all other clinical outcomes and complications were no different.

Varela et al. [6] used a cross-sectional design with historical controls to evaluate the cost-effectiveness of chest physiotherapy following lobectomy. A total of 119 subjects who were undergoing lobectomy, more commonly by video-assisted thoracoscopic surgery (VATS) than by thoracotomy, received intensive chest physiotherapy starting one day before surgery and continuing until hospital discharge. The subjects received instruction in deep breathing exercises and coughing, and exercised using a static bicycle and treadmill. They were compared with a historical control group of 520 patients who had a lobectomy, more commonly by muscle sparing thoracotomy than VATS (although the exact proportion is not reported) at the same hospital. The control group received routine nursing care with IS. Nosocomial pneumonia and atelectasis rates were higher in the control group, but only atelectasis rates demonstrated a significant difference (2% vs. 7.7%, odds ratio 0.20; 95% CI 0.05–0.86). The median length of stay was 5.7 days (range 3–22 days) in the physiotherapy group and 8.3 days (range 3–40 days) in the control group ($P<0.0001$). Cost analysis demonstrated a reduction in overall expenditure for hospital treatment in the physiotherapy group, but this did not include out-of-hospital costs caused by complications. The authors therefore refute the fact that the difference between the groups could be accounted for by a more extensive use of the VATS approach in the physiotherapy group.

Weiner et al. [7] performed a prospective randomised controlled trial studying the effect of IS and inspiratory muscle training (IMT) on predicted postoperative pulmonary function following lung resection. Thirty-two patients with COPD were randomised. One group received preoperative physiotherapy input consisting of IS with IMT for one hour a day six times a week for two weeks preoperatively and then for three months postoperatively. The other group received none of this training. The intervention group was found to have better predicted postoperative FEV_1 than the control group at three months. However, it is uncertain whether this improvement in predicted postoperative FEV_1, can be attributed to the volume effect of IS or the 'loading' effect of IMT. This paper was not primarily concerned with the use of these treatments for preventing PPCs, but the authors did note that there were two cases of postoperative pneumonia in each group.

7. Clinical bottom line

We conclude that a preoperative physiotherapy/pulmonary rehabilitation programme improves exercise capacity in patients undergoing thoracotomy and lung resection, and in patients with COPD preserves pulmonary function following surgery. Whether these benefits translate into a reduction in the development of PPCs is uncertain.

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