A Meta-Analysis Comparing Muscle-Sparing and Posterolateral Thoracotomy

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We compared outcomes of posterolateral thoracotomy vs muscle-sparing thoracotomy after open thoracic operations. Twelve trials were included, comprising 571 patients in the muscle-sparing thoracotomy group and 512 patients in the posterolateral thoracotomy group. There was significantly improved shoulder internal rotation (weighted mean difference, –1.28; 95% confidence interval, –2.45 to –0.11; $p = 0.03$) and pain scores on day 7 (weighted mean difference, –0.76; 95% confidence interval, –1.26 to –0.27; $p = 0.002$) but higher seroma rates (odds ratio, 8.26; 95% confidence interval, 2.16 to 31.56; $p = 0.002$) in the muscle-sparing thoracotomy group compared with the posterolateral thoracotomy group. We advocate using muscle-sparing thoracotomy, especially on patients dependant on quicker recovery of shoulder function.

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A posterolateral thoracotomy (PLT) in which muscles are divided is still the standard approach for most thoracic surgical procedures. It has the advantage of providing good access and can be easily and quickly extended if greater access becomes necessary. Although the choice of thoracotomy incision is guided primarily by the exposure required to perform a safe procedure, cosmesis and the potential for improved recovery should also be considered. PLT requires the division of the latissimus dorsi (LD) and sometimes other chest wall muscles such as trapezius, the rhomboids, and serratus anterior (SA). As a result, PLT may be associated with considerable morbidity, including postoperative pain, impaired lung function, and compromised function of the shoulder girdle [1–3].

In an attempt to decrease these shortcomings, less invasive thoracotomy procedures, such as muscle-sparing thoracotomy (MST) [4–9] and video-assisted thoracoscopic surgery (VATS), [10] have been introduced. Various types of MSTs have been proposed during the last 25 years, including vertical and transverse axillary thoracotomy [4, 5], auscultatory triangle thoracotomy [6], limited lateral thoracotomy [7], and muscle-sparing posterolateral thoracotomy [8]. By using a more limited muscle dissection than PLT, there is the potential for MST to reduce postoperative pain, allow better respiratory and lung function by preserving accessory muscles, and reduce postoperative complications. However, the difference in the postoperative outcomes between these techniques remains undetermined.

Several trials have assessed MST compared with PLT after thoracic procedures [10–22]. A meta-analysis of these trials allows a pooled analysis, thereby minimizing any type II error. The purpose of this meta-analysis was to assess the clinical outcomes of MST compared with PLT after open thoracic procedures.

Material and Methods

An electronic search was performed using the MEDLINE, CINAHL, DARE, ACP, LILACS, SCOPUS, Google Scholar, and EMBASE databases from 1966 to 2010. The search terms "Thoracotomy," "Posterolateral," "Muscle sparing," "Minimal invasive," "Thoracic," "Limited," "Standard," "Randomised trial," "Randomized trial," "Trial," "Prospective," "Retrospective," "Anterolateral," "Axillary," "Vertical," and "Anterior," and MeSH headings "Thoracotomy" (MeSH), "Thoracic" (MeSH) "Surgery" (MeSH) were used in combination with the Boolean operators "*and*" or "*or*." The criteria were widened further by using the "related article" function during the search. Two authors conducted the electronic searches independently in March 2012.

This search was supplemented by a hand search of published abstracts from 1980 to 2010 in meetings of the Society of Academic and Research Surgery, Surgical Research Society, Society of Cardiothoracic Surgeons (SCTS), World Congress of Cardiothoracic Surgery, The European Society of Cardiothoracic Surgeons, and The American Association of Thoracic Surgery (AATS). Finally, the Current Controlled Trials Register, The Cochrane Database Of Controlled Trials, and Science Citation Index Expanded were searched.

The reference lists of all articles obtained were also examined to identify additional relevant studies. Review

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articles were obtained to determine other possible studies. Trials were included irrespective of the language in which they were published. We applied the guidelines for Meta-analysis of Observational Studies in Epidemiology (MOOSE) [23].

Study Eligibility

Eligibility for study inclusion into the meta-analysis and study quality assessment was performed independently by 2 of the authors (M.U. and P.M.). Study data were extracted onto standard forms. Any disagreements were resolved by the third author (D.R.). Studies were included if they were trials in which direct comparisons were made between patients who had PTL vs MST during a thoracic surgical procedure. A posterolateral thoracotomy procedure *must* involve division of the latissimus dorsi muscle. An MST approach *does not* allow division of the latissimus dorsi muscle but can allow division of other muscles such as SA or trapezius. Any unclear or missing information was obtained by contacting the authors of the individual trials. For duplicate publications, the smaller data set was excluded. Any data directly comparing a VAT approach vs thoracotomy techniques were excluded from the analysis.

The quality of each study was assessed by use of Newcastle-Ottawa scale, a 9-point scale that assigns points on the basis of the process of selection (0 to 4 points), comparability (0 to 2 points), and identification of the outcomes of study participants (0 to 3 points) [24].

The primary outcome measures were lung function tests measured by forced expiratory volume in 1 second (FEV_1) and vital capacity (VC), range of shoulder movement (in degrees) at 30 days, and pain score on a linear visual analog scale at 1, 7, and 30 days after the operation. Secondary outcomes were duration of operation (in minutes), incision size (in cm), hospital stay (in days), and overall documented complication rates, including seroma. The duration of operation was defined as the time taken to perform the procedure starting from knife-to-skin through completion of skin closure. Only trials that reported at least one of the primary or secondary outcome measures were included in the meta-analysis.

Statistical Analysis

Data from the individual eligible studies were entered into a spreadsheet for further analysis. StatsDirect 2.5.7 software (StatsDirect, Altrincham, UK) was used to perform the statistical analysis. Weighted mean differences (WMD) were calculated for the effect size of continuous variables such as duration of surgery and postoperative visual analog scale pain scores. Pooled odds ratios (OR) were calculated for discrete variables such as complication and seroma rate. A positive WMD and an OR of less than 1.00 favors PLT, whereas a negative WMD or an OR of less than 1.00 favors MST.

Random effects models (DerSimion Laird) were used to calculate the outcomes of binary and continuous data to control any heterogeneity among the studies. Heterogeneity among the trials was determined by means of the Cochran Q value and quantified using the I^2 inconsistency test. In this study, we did not perform meta-regression or sensitivity analysis because of the small number of studies included. All p values were 2-sided, and a 5% level was considered significant.

Results

The initial search identified 58 publications (Fig 1). The meta-analysis included 13 publications describing 12 trials that fulfilled the inclusion criteria [10–22]. Publication dates ranged from 1991 to 2010. There were 1,083 patients, of whom 512 had PLT and 571 had MST. There were no baseline imbalances in age, sex, or body mass index between the two groups. Trial details are reported in Table 1 and Table 2, including details of study design, sample size, intervention, and follow-up.

Primary Outcome

LUNG FUNCTION TESTS. Six studies reported the percentage change in FEV_1 after 30 days [10, 12, 14, 16, 18, 21]. There was no statistical heterogeneity between studies (Cochran $Q = 3.13$, $p = 0.68$; $I^2 = 0\%$, 95% confidence interval [CI], 0% to 61%). In the random effects model, there was no significant difference in the FEV_1 compared with preoperative levels between the PLT and MST group (pooled WMD, 2.74; 95% CI, –0.92 to 6.41; $p = 0.14$; Table 3).

Five studies reported the percentage change in VC after 30 days [12, 14, 15, 18, 21]. There was statistical heterogeneity between studies (Cochran $Q = 11.39$, $p = 0.02$; $I^2 = 64.9\%$, 95% CI, 0% to 84.5%). In the random effects model, there was no significant difference in the VC compared with preoperative levels between the PLT and MST group (pooled WMD, 3.10; 95% CI, –3.05 to 9.24; $p = 0.32$; Table 3).

SHOULDER MOVEMENTS. Three studies reported the range of shoulder movement after 30 days [12, 18, 21].

For shoulder abduction, there was no statistical heterogeneity between studies (Cochran $Q = 0.40$, $p = 0.82$; $I^2 = 0\%$, 95% CI, 0% to 72.9%). In the random effects model, there was no significant difference in shoulder abduction between the PLT and MST group at 30 days (pooled WMD, 2.33; 95% CI, –0.69 to 5.35; $p = 0.13$; Table 3).

For shoulder flexion, there was statistical heterogeneity between studies (Cochran $Q = 11.95$, $p = 0.002$; $I^2 = 83.3\%$, 95% CI, 2.8% to 92.7%). In the random effects model, there was no significant difference in shoulder flexion between the PLT and MST group at 30 days (pooled WMD, 8.18; 95% CI, –1.65 to 18.01; $p = 0.10$; Table 3).

For internal rotation, there was no statistical heterogeneity between studies (Cochran $Q = 2.24$, $p = 0.32$; $I^2 = 10.9\%$, 95% CI, 0% to 75.7%). In the random effects model, postoperative internal rotation was significantly better at 30 days in the MST group than in the PLT group (pooled WMD, –1.28; 95% CI, –2.45 to –0.11; $p = 0.03$; Fig 2 and Table 3).

For external rotation of the shoulder, there was statistical heterogeneity between studies (Cochran $Q = 14.22$,

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