Is muscle-sparing thoracotomy advantageous?

Kas koruyucu torakotomi avantajlı mı?

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Background: The aim of this study was to compare muscle-sparing thoracotomy for the latissimus dorsi and the serratus anterior muscles (MST-L), and muscle-sparing thoracotomy for serratus anterior muscle (MST-S) with each other and with standard posterolateral thoracotomy (SPLT) in terms of advantages and disadvantages.

Methods: Sixty patients (18 females, 42 males; mean age 42.6±16.6 years; range 15 to 72 years) in whom thoracotomy was indicated were randomly grouped into three categories. The groups were compared in terms of the effects of thoracotomy on shoulder range of motion, muscle strength, pulmonary function, postoperative pain, and duration of hospitalization.

Results: Shoulder range of motion and serratus anterior muscle strength in the SPLT group were significantly lower than in the other groups. The latissimus dorsi muscle strength in the MST-L group was significantly better than that of the other groups. The parameters of pulmonary function on days 3 and 7 in the MST-L group were significantly better than those of the other groups. The duration of hospitalization in the MST-L group was significantly shorter than that of the other groups.

Conclusion: The improvement of pulmonary function occurs earlier in thoracotomies that spare the chest wall muscles, and postoperative complications due to detachment are decreased. Although there is a better field of view in SPLT and MST-S than that of MST-L, considering the other advantages of MST-L, we recommend initiating with MST-L in all thoracotomies, except in emergency cases.

Key words: Muscle-sparing thoracotomy; standard posterolateral thoracotomy; vertical thoracotomy.

Amaç: Bu çalışmada latismus dorsi ve serratus anterior kasları birlikte korunarak (KKT-L) ve serratus anterior kası tek başına korunarak yapılan kas koruyucu torokotomileri (KKT-S) birbirleri ile ve standart posterolateral torakotomiler (SPLT) ile avantaj ve dezavantajları açısından karşılaştırıldı.

Çalışma planı: Çalışmaya torakotomi endikasyonu olan 60 hasta (18 kadın, 42 erkek; ort. yaş 42.6±16.6 yıl; dağılım 15-72 yıl) alındı ve hastalar rasgele üç gruba ayrıldı. Gruplar torakotominin, omuz hareket açıklığına, kas güçlerine, akciğer fonksiyonlarına, ameliyat sonrası ağrı durumuna ve hastanede kalış süresine etkileri açısından karşılaştırıldı.

Bulgular: Omuz hareket açıklığı ve serratus anterior kas gücü SPLT grubunda diğer gruplara göre anlamlı derecede düşük idi. Latismus dorsi kas gücü KKT-L grubunda diğer gruplara göre anlamlı ölçüde daha iyi idi. Akciğer fonksiyon parametrelerinin 3. ve 7. günde KKT-L grubunda diğer gruplara göre anlamlı ölçüde daha iyi olduğu görüldü. Hastanede kalış süresi KKT-L grubunda diğer gruplara göre anlamlı ölçüde kısa idi.

Sonuç: Göğsün duvar kasları korunarak yapılan torakotomilerde solunum fonksiyonları daha erken düzelmekte, kasların kesilmesine bağlı olarak gelişen ameliyat sonrası komplikasyonlar azalmaktadır. Her ne kadar SPLT ve KKT-S ile elde edilen görüş alanı KKT-L'ye göre daha iyi olsa da KKT-L'nin sağlayacağı diğer avantajlar göz önünde tutularak acil durumlar dışında bütün torakotomilerin KKT-L ile başlatılmasını önermekteyiz.

Anahtar sözcükler: Kas koruyucu torakotomi; standart posterolateral torakotomi; vertikal torakotomi.

The standard posterolateral thoracotomy (SPLT) provides excellent exposure of the field for intrathoracic surgical interventions. However, it has some disadvantages, including dissection of major muscle groups, postoperative pulmonary failure, limitation of mobility, limitation of shoulder and upper extremity mobility, postoperative pain and cosmetic problems.[1-3]

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Deformities of the vertebrae, shoulder girdle, breast and chest wall are the major sequelae of muscle-cutting thoracotomies.[4-6] These sequelae are thought to be due to severance of the major motor nerves and rib resections. The related significant shoulder deformities have been considered to be due to the complete denervation of serratus anterior and latissimus dorsi muscles. The latissimus dorsi muscle has a role in deep inspiration and forceful coughing, in addition to the action of the shoulder girdle. It is also an accessory muscle in expiration. As it is dissected in SPLT, the functions are reduced.[4-6] Thus, "muscle-sparing" thoracotomy (MST) has recently gained great interest. The aims of muscle-sparing thoracotomy are: minimizing cosmetic problems, decreasing the pain and the need for narcotic analgesics after thoracotomy, improving pulmonary function in the early postoperative period, sparing the range of motion (ROM) in the upper extremity and the muscle strength in the chest wall muscles and conserving these muscles for probable future myoplastic procedures.[7]

The aim of this study was to compare muscle-sparing thoracotomy for latissimus dorsi and the serratus anterior muscles (MST-L), muscle-sparing thoracotomy for serratus anterior muscle (MST-S) and SPLT in terms of advantages and disadvantages.

PATIENTS AND METHODS

This study included 60 patients (18 females, 42 males; mean age 42.6±16.6 years; range 15 to 72 years) who had electively undergone thoracotomy from May 2007 to March 2009 in the Thoracic Surgery and Pediatric Surgery Clinics. The conditions that may have affected the ROM and the muscle strength were questioned. A physiatrist preoperatively performed physical examinations.

Cases with abnormal findings were excluded from the study. The patients were randomized into three groups of 20 patients in each: The first group underwent the SPLT; the second group underwent MST-L, and the third group underwent MST-S.

Ipsilateral shoulder ROM was assessed using goniometer by the physiatrist who was blinded to the operation technique. Muscle strength measurements were performed preoperatively and on the 7th, 15th and 30th postoperative days using the manual muscle test. We aimed to determine whether or not ipsilateral shoulder ROM was affected and, if so, the time for the recovery in the three groups. The affected shoulder was monitored for flexion, external rotation, internal rotation and abduction.

Muscle strength was assessed preoperatively and postoperatively (On days 3, 7 and 30) using the Lovett method (0-5 score) in the three groups. Pulmonary function tests (vital capacity; VC, forced vital capacity FVC, forced expiratory volume in 1 second; FEV_1) were performed preoperatively and postoperatively (on days 3, 7 and 30) using the Microlab MK6 device to compare the effects of three techniques on pulmonary function. The duration of hospitalization was assessed in the three thoracotomy techniques.

The data were analyzed using the SPSS (Statistical Package for Social Sciences; SPSS Inc., Chicago, Illinois, USA) for Windows 15.0 program. The mean and standard deviation were used to compare quantitative data. The one-way ANOVA test was used for inter-group comparison of parameters showing normal distribution. The Tukey HDS test was used to find the group causing the difference. The Kruskal-Wallis test was used for inter-group comparison of parameters not showing normal distribution. The Mann-Whitney U-test was used to find the group causing the difference. The variance analysis and paired sample t-tests were used to find the difference between recurrent measurements of parameters with normal distribution. The Friedman test was used to find the difference between recurrent measurements of parameters without a normal distribution. The Wilcoxon sign test was used for intra-group comparisons. The Chi-square test was used to compare qualitative data. The results were assessed with 95% confidence interval. The level of significance was set at $p<0.05$.

RESULTS

There was no significant difference between the groups in terms of age and gender ($p>0.05$). There was no significant difference between the groups in terms of preoperative shoulder ROM ($p>0.05$).

There was a significant difference in the intra-group comparison of the degree of abduction, flexion, internal rotation and external rotation on days 7, 15 and 30 ($p<0.01$). The mean abduction, flexion, internal rotation and external rotation degrees of group 1 on days 7, 15 and 30 were considerably lower than those of group 2 ($p<0.01$) and group 3 ($p<0.01$); there was no significant difference between Group 2 and group 3 in terms of the mean abduction and external rotation degree ($p>0.05$). While the mean flexion degree of group 2 on days 7 and 15 was considerably higher than that of group 3 ($p<0.05$), there was no significant difference between the mean flexion degrees of either of the two groups on day 30 ($p>0.05$). While the mean internal rotation degree of group 2 and group 3 on days 7 and 15 was not significantly different ($p>0.05$), the mean internal rotation degree of group 2 on day 30 was significantly higher than that of group 3 ($p<0.05$; Table 1).

Table 1. Results of shoulder joint range of movement

	Group 1	Group 2	Group 3	*p*	*p*	*p*
	Mean±SD	Mean±SD	Mean±SD	Group 1-2	Group 1-3	Group 2-3
Abduction						
Preoperative	170.2±6.1	171.0±6.3	168.1±5.7	>0.05	>0.05	>0.05
Day 7	131.6±14.4	155.0±11.9	150.5±12.3	0.001	0.001	0.511
Day 15	150.5±8.9	166.4±7.9	163.3±8.9	0.001	0.001	0.495
Day 30	161.2±8.5	173.1±4.2	171.3±6.9	0.001	0.001	0.455
Flexion						
Preoperative	173.1±4.1	173.6±4.4	170.6±4.0	>0.05	>0.05	>0.05
Day 7	135.9±16.8	158.2±10.6	146.8±11.3	0.001	0.030	0.022
Day 15	151.9±8.6	171.3±5.2	163.2±7.6	0.001	0.001	0.003
Day 30	157.3±7.7	173.2±4.4	171.1±7.5	0.001	0.001	0.591
Internal rotation						
Preoperative	61.0±5.1	62.7±4.7	62.1±5.0	>0.05	>0.05	>0.05
Day 7	34.4±8.8	50.4±7.0	46.0±4.1	0.001	0.001	0.133
Day 15	40.4±6.1	57.1±4.1	54.4±6.1	0.001	0.001	0.133
Day 30	49.9±4.9	63.3±3.7	59.3±6.0	0.001	0.001	0.035
External rotation						
Preoperative	78.6±4.7	79.9±4.6	79.1±3.7	>0.05	>0.05	>0.05
Day 7	49.8±7.6	63.3±6.7	58.4±6.1	0.001	0.001	0.071
Day 15	56.0±7.0	69.2±5.8	64.3±6.1	0.001	0.001	0.046
Day 30	62.8±4.9	72.7±4.9	69.3±5.3	0.001	0.001	0.100

SD: Standard deviation.

The latissimus dorsi muscle strength of group 2 was considerably higher than that of group 1 (p<0.01) and group 3 (p<0.01) on days 3, 7 and 30. While the latissimus dorsi muscle strength in group 1 and group 3 on days 3 and 7 was not significantly different (p>0.05), the latissimus dorsi muscle strength of group 3 on day 30 was significantly higher than that of group 1 (p<0.01; Table 2).

The serratus anterior muscle strength in the three groups on days 3, 7 and 30 was significantly different (p<0.01). The serratus anterior muscle strength of group 1 was significantly lower than that of group 2 (p<0.01) and group 3 (p<0.01). There was no significant difference between the serratus anterior muscle strength of group 2 and group 3 (p>0.05; Table 2).

The degree of pain was considerably lower at the 4th, 16th and the 24th hour in group 2 than that of group 1 (p<0.01) and group 3 (p<0.01). The degree of pain was considerably higher at the 48th and the 72nd hour in group 1 than that of group 2 (p<0.01) and group 3 (p<0.01). The degree of pain was considerably lower at the 16th and the 24th hour of group 3 than that of group 1 (p<0.01). The degree of pain was significantly higher at the 48th hour of group 3 than that of group 2 (p=0.047; p<0.05). There was no significant difference between the degree of pain of group 2 and group 3 at the 72nd hour

Table 2. Muscle strength results of latissimus dorsi and serratus anterior

	Group 1	Group 2	Group 3	*p*	*p*	*p*
	Mean±SD	Mean±SD	Mean±SD	Group 1-2	Group 1-3	Group 2-3
Latissimus dorsi						
Preoperative	4.6±0.5	4.5±0.5	4.5±0.5	>0.05	>0.05	>0.05
Day 3	2.4±0.5	3.6±0.5	2.6±0.5	0.001	0.348	0.001
Day 7	2.7±0.5	3.7±0.5	2.8±0.4	0.001	0.471	0.001
Day 30	3.3±0.4	4.4±0.6	3.7±0.7	0.001	0.002	0.002
Serratus anterior						
Preoperative	4.6±0.5	4.7±0.5	4.7±0.5	>0.05	>0.05	>0.05
Day 3	2.2±0.4	3.4±0.5	3.4±0.5	0.001	1.000	0.001
Day 7	2.6±0.5	3.4±0.5	3.6±0.5	0.01	0.001	0.348
Day 30	3.2±0.6	4.3±0.6	4.3±0.7	0.001	0.001	0.786

SD: Standard deviation.

Table 3. The degree of pain and the daily need for analgesic

	Group 1	Group 2	Group 3	*p*	*p*	*p*
	Mean±SD	Mean±SD	Mean±SD	Group 1-2	Group 1-3	Group 2-3
Degree of pain						
Hour 0	8.5±1.0	8.0±0.9	8.6±0.8	>0.05	>0.05	>0.05
Hour 4	7.3±0.8	5.9±0.8	6.6±0.9	0.001	0.022	0.008
Hour 16	6.2±0.9	3.5±0.6	5.1±0.9	0.001	0.001	0.001
Hour 24	4.3±0.1	2.3±0.5	3.1±0.8	0.001	0.001	0.001
Hour 48	2.5±0.7	1.5±0.5	1.9±0.6	0.001	0.008	0.047
Hour 72	1.9±0.6	1.5±0.5	1.5±0.5	0.047	0.047	1.000
Day 7	1.5±0.6	1.2±0.4	1.3±0.4	p>0.05	p>0.05	p>0.05
Day 30	0.8±0.5	0.4±0.5	0.4±0.5	p>0.05	p>0.05	p>0.05

SD: Standard deviation.

(p=1.000; p>0.05). There was no significant difference between the degree of pain between the groups on the 7th and 30th postoperative days (p>0.05; Table 3).

The pulmonary function test parameters (VC, FVC, and FEV1) were assessed in the three groups postoperatively. There was no significant difference between the groups preoperatively and on day 30 (p>0.05). There was a significant difference between the groups on day 3, 7 and 30 in pulmonary function test parameters (p<0.01). The VC, FVC and FEV1 levels of group 2 on the 3rd and 7th days were considerably higher than that of group 1 (p<0.01) and group 3 (p<0.01). The levels of VC, FVC and FEV1 of group 1 on the 30th day were considerably lower than that of group 2 (p<0.01) and group 3 (p<0.01). The pulmonary function test levels of group 3 on the 3rd and 7th days were significantly higher than that of group 1 (p<0.05). There was no significant difference between VC, FVC and FEV1 levels of group 2 and group 3 on the 30th day (p>0.05; Table 4).

The length of stay in hospital was significantly different between the groups (p<0.01). The duration of stay in hospital of group 2 (6.4±1.2) was significantly shorter than that of group 1 (9.8±2.8) (p=0.001; p<0.01) and group 3 (7.9±1.1) (p=0.001; p<0.01). The duration of stay in hospital of group 3 was significantly shorter than that of group 1 (p=0.010; p<0.05).

DISCUSSION

The standard posterolateral thoracotomy is the favorite standard incision of many thoracic surgeons due to the fact that it provides excellent exposure of the lung hilum, mediastinum and lungs. The main disadvantage of this approach is cutting the major muscles of the chest wall (latissimus dorsi and serratus anterior).[8] Thus, MST has gained considerable attention lately. Muscle-sparing thoracotomy has undergone criticism due to the small incision and not providing an adequate exposure for major pulmonary resections.

Table 4. Pulmonary function test results

	Group 1	Group 2	Group 3	*p*	*p*	*p*
	Mean±SD	Mean±SD	Mean±SD	Group 1-2	Group 1-3	Group 2-3
Vital capacity						
Preoperative	2.8±0.2	2.7±0.2	2.7±0.3	>0.05	>0.05	>0.05
Day 3	1.9±0.3	2.4±0.2	2.1±0.2	0.001	0.015	0.001
Day 7	2.0±0.3	2.4±0.2	2.1±0.2	0.001	0.015	0.001
Day 30	2.5±0.2	2.6±0.2	2.7±0.3	>0.05	>0.05	>0.05
Forced vital capacity						
Preoperative	2.7±0.2	2.6±0.2	2.6±0.3	>0.05	>0.05	>0.05
Day 3	1.3±0.2	1.7±0.2	1.5±0.1	0.001	0.001	0.001
Day 7	1.5±0.1	2.1±0.2	1.8±0.1	0.001	0.001	0.001
Day 30	1.9±0.1	2.4±0.4	2.4±0.3	0.001	0.001	0.995
Forced expiratory volume in 1 second						
Preoperative	2.4±0.4	2.5±0.3	2.5±0.3	>0.05	>0.05	>0.05
Day 3	1.3±0.1	1.6±0.2	1.4±0.1	0.001	0.001	0.001
Day 7	1.4±0.1	2.0±0.2	1.7±0.1	0.001	0.001	0.001
Day 30	1.8±0.1	2.3±0.3	2.3±0.2	0.001	0.001	0.692

SD: Standard deviation.

Lemmer et al.[1] reported that early postoperative pulmonary reserve-dependent spirometry testing volumes were more favorable in the group undergoing MST-L than in the group undergoing SPLT. Ginsberg[9] confirmed the same findings.

We found MST to be the method least affecting the pulmonary function in the early postoperative period, and that MST-S has a significantly better sparing of pulmonary function parameters than SPLT. In contrast to the literature,[10] it was found that pulmonary function test parameters on day 30 in group 1 did not return to preoperative levels and that pulmonary function test parameters in group 2 and group 3 improved significantly better than that of group 1 (Table 4).

Hennington et al.[11] observed that spared latissimus dorsi and serratus anterior muscles enable easy regaining of upper extremity functions and mobility. It was shown that MST was significantly superior to the standard thoracotomy in terms of early postoperative shoulder function.[10]

In our study, shoulder ROM was significantly less in group 1 cases than in group 2 and group 3 cases (Table 1). It was reported that there was a significant loss of strength in the latissimus dorsi and serratus anterior muscles in cases undergoing SPLT in the first postoperative week. The muscle strength was protected in cases undergoing MST.[10] In both techniques, it took more than a month to achieve the preoperative strength of the shoulder.

The muscle strength for latissimus dorsi on the 3rd, 7th and 30th days of group 2 in our study was significantly higher than that of group 1 and group 3 for all three thoracotomy methods. The muscle strength of the serratus anterior of group 1 was significantly lower than that of group 2 and group 3. There was no significant difference in the serratus anterior muscle strength in group 2 and group 3 (Table 2).

With regard to postoperative pain and analgesic need due to thoracotomy, several studies have been reported in favor of muscle-sparing methods. Hazelrigg et al.[10] found that the mean daily scores of visual analog scale (VAS) and the analgesic need were decreased in MST. It was reported that the majority of postoperative pain was related to bone fracture and fissure.[4] It was suggested that the decrease in postoperative wound pain[12] and the protection of the major thoracic muscles[3,13] were the main benefits of MST, and these contribute the improvement of postoperative pulmonary function.

Sugi et al.[14] found that the mean daily VAS score on the 1st, 3rd, and 5th postoperative days was significantly lower in the MST-L group other to the group. Thus, the need for narcotic analgesic on days 1, 3 and 5 was lower in patients undergoing MST-L.

We did not find a significant difference in our study between the groups for the severity of pain on days 7 and 30. However, the severity of pain in the first postoperative 48 hours of group 2 was significantly lower than that of group 1 and group 3. The severity of pain of group 3 was lower than that of group 1. Similarly, while the need for analgesics for all days of group 1 was higher than that of group 2 and group 3, there was no significant difference in the levels of analgesic need after day 3 in group 2 and group 3 (Table 3). It was reported that the time required for reaching the pleural cavity was 10 minutes longer in MST-L when compared to the standard thoracotomy.[9] This time is needed for subcutaneous dissection and releasing of the serratus anterior and latissimus dorsi muscles. As these muscles do not require approaching during closure of the thoracotomy, the lost time may be regained by this fast closure.[15]

The difference between the duration of stay in the hospital was significant between the groups ($p<0.01$). The length of hospitalization in group 2 (6.4 ± 1.2) was significantly shorter than that of group 1 (9.8 ± 2.8) ($p=0.001$; $p<0.01$) and group 3 (7.9 ± 1.1) ($p=0.001$; $p<0.01$). The duration of hospitalization in group 3 was significantly shorter than that of group 1 ($p=0.010$; $p<0.05$).

In their randomized prospective study, Kirby et al.[15] reported that in patients undergoing lobectomy by using the method of MST-L with video-assisted thoracoscopic surgery (VATS), which was a less invasive intervention, there was no significant difference in the operation time, intraoperative blood loss, drainage time of chest tube and the duration of hospitalization. We found that the duration of hospitalization in our study was longer in patients undergoing SPLT compared to the other two groups.

In their multi-function study of 30 cases with primary lung cancer in 1996, Sugi et al.[14] compared exposure, operation time, postoperative pain, shoulder mobility and pulmonary function tests. There was less exposure, longer operating time and better shoulder function in MST-L, with no difference in pulmonary function. They suggested that this method had no advantage in cancer surgery compared to SPLT.[15] We found all data related to these parameters in favor of MST-L and MST-S.

In their six-year retrospective study in 2004, Küçükarslan et al.[16] reported that 40 patients undergoing MST-L demonstrated a shorter time in regaining normal pulmonary function and extremity movements, and that the surgical incision was aesthetic, but that there were complications of delayed air leakage (7.5%) and seroma (5%). We did not encounter such complications.

Akçalı et al.[4] compared SPLT and MST-L in their study with 60 cases in 2000 and found that postoperative pain, analgesic need, improvement in pulmonary functions, blood gas values, and shoulder ROM in MST-L were more favorable, and the opening time was longer. Seroma as complication developed in 16.6% of patients. We had no seroma, and the opening, closing and total times were shorter in group 2 and group 3 than in SPLT.

In conclusion, in patients undergoing MST-L, the time needed to regain normal pulmonary function and normal extremity movements was found to be considerably shorter, there were fewer complications, and the outcome of the surgical incision was aesthetic. This is important in lung resections. As the chest wall muscles were spared, pulmonary function improved earlier and postoperative-related complications were decreased.

We found in our study that SPLT and MST-S were superior to MST-L. Therefore, we believe that except in emergency cases, all thoracotomies should be initiated as MST and if larger exposure is needed during the operation, the incision should be changed to MST-S or the standard muscle-dissecting thoracotomy.

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