Lung- Sparing, Damage Control Surgery for Major Thoracic Trauma

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This prospective study was carried out in the Department of Surgery, Mayo Hospital and Jinnah Hospital, Lahore from September 1998 to August 2001. A total of 23 patients were included in the study who underwent thoracotomy for pulmonary injuries. Age ranged from 13-62 years with mean age of 31 years and the patients were predominantly males (82.6%). Penetrating trauma was the main cause of thoracic injuries affecting 74% of patients. Associated injuries were found in 66% of patients with blunt trauma but only29% of penetrating trauma victims. Damage control lung sparing surgery was performed and 39% patients suffered postoperative complications. Overall mortality after lung sparing surgery was 12.5% and after major resection 40%. The study emphasizes the importance of lung sparing surgical techniques, which are associated with lesser complications as compared to major pulmonary resections.

Key words: Thoracic trauma, damage control, lung sparing surgery

Thoracic trauma is common, occurring in one third of all trauma victims and responsible for a quarter of deaths due to polytrauma.[1] While most patients are managed by tube thoracostomy but a major surgical intervention; thoracotomy is indicated in 10-15% of cases[2,3]. Major lung resection (lobectomy and pneumonectomy) is associated with very high mortality ranging from 50-100%[4]. The main contributing factors for this gloomy outcome are prolonged operative time, uncontrolled bleeding with massive transfusion, coagulopathies and acidosis.[5] This has led to the concept of " thoracic damage control surgery" which emphasize on simpler, rapid but definitive procedures with minimal physiological insult.

The operations in the chest are almost exclusively performed for severe intrathoracic hemorrhage. The hemostasis can be achieved in all injuries not involving central vessels and main bronchi by lung sparing surgical techniques like tractotomy, wedge resection and pneumonorrhaphy[2]. Major resections are reserved for non-salvageable parenchymal injuries and injuries involving central vessels and main bronchi.[5] We under took this study to evaluate the role of lung sparing surgical techniques in the management of thoracic trauma in our setup.

Materials and Methods:

This prospective study was carried over a period of three years, from 1st September 1998 to 30th August 1999 in Mayo hospital and later on continued in Jinnah hospital till August 2001. A total of 231 patients with thoracic trauma were treated in emergency department but our study population was limited to those 23 patients who under went thoracotomy for lung injuries. Patients with isolated cardiac, major vascular and esophageal injuries were not included in study. Demographic data collected included mechanism of injury, gender and age. Injury was characterized by Injury Severity Score (ISS) and specific thoracic injuries, as well as associated injuries were recorded. Physiological data collected were systolic blood pressure on admission, oxygen saturation and PH level.

Patients with hemodynamic instability due to blood loss were taken immediately to the operating room. An immediate chest tube yield of 1500 ml or continued loss 300 ml/hour for more than 3 hours was considered an indication for thoracotomy. Massive air leak due to injury to main bronchi or bronchus were other reasons for thoracotomy. Surgical access to injured lung was usually achieved by posterolateral thoracotomy. Double lumen endotracheal intubation was preferable but single lumen tube was used commonly, because of availability and need for rapid airway access. After opening the thoracic cavity, injury to the lung was evaluated and specific procedure planned. In the presence of profuse bleeding or significant air leak from central cavity, corresponding hilar pedicle was cross-clamped temporarily.

Pulmonary tractotomy was commonest procedure used, tract was opened and individual ligation of exposed vessels or bronchi was used to control bleeding or air leaks. Peripheral injuries were managed by wedge resection. Both these procedures were performed with vascular clamps; GIA stapler is preferable but used only in few cases because of non-availability. Pneumonorrhaphy was used only for superficial lacerations. Anatomical lobectomy and pneumonectomy were reserved for hilar injuries and extensive injuries not amenable by simpler procedures.

Chest complications were defined as: persistent air leak was defined as air leak more than 7 days. Pneumonia was defined as presence of following: leukocyte count more than 12,000, temperature >38.5°C, chest radiograph showing parenchymal consolidation or infiltrate and positive sputum cultures, Empyema was defined as, in addition to features of pneumonia the presence of pleural fluid which have LDH of >500 IU and positive culture or Gram's stain. Presence of ARDS was indicated by the need for postoperative ventilation due to hypoxemia in presence of normal filling pressure. Need for reoperation,

its indication and any mortality were recorded carefully. Statistical analysis was carried out employing exact Fisher test, chi-square test, and analysis of variance for comparative analysis of the data using IBM-compatible PC utilizing SPSS 10.0 for Windows (SPSS Inc., Chicago).

Results:

Over 3 years study period, a total of 231 patients were received in emergency department during our on call but our study population comprised of 23 (9.95%) cases who underwent thoracotomy, with 20 (86.9%) requiring some form of lung resection. Males were the main victims, 19(82.6%) and 4(17.4%) were females. Age ranged from 13-62 years, with mean age of 31 years. Penetrating trauma was the commonest 17(74%), which comprised 12 gunshot and 5 stabs, while 6(26%) suffered from blunt thoracic trauma. Associated injuries were observed in 4/6 cases of blunt trauma but only in 5/17 patients with penetrating trauma, out of these 6 patients underwent laparotomy and revealed following injuries, liver (3), spleen (1), stomach (I), small intestine (2) and colon (1), while among the remaining three one had head injury and others suffered from limb injuries.

The injury characteristics and physiological parameters in patients who underwent lung resection are shown in table 1. Statistical comparisons are of limited value in this study because of very small number of patients in various groups but they appear to be comparable. Overall these parameters were on higher side in blunt trauma as compared to penetrating trauma. It was observed that the incidence of major resections was higher (2/6) in blunt trauma as compared to penetrating trauma (2/17) patients. The various surgical procedures performed are shown in table 2. The postoperative course like number of days spent in ICU, mechanical ventilation required, duration of tube thoracostomy, total stay in hospital and morbidity are compared in table 3.

The overall 9(39.1%) patients had complications that were directly related to lung surgery, six (35.2%) in lung sparing group and three (50%) in major resection group. These complications are listed in table 4. Two patients developed persistent air leak, one settled on conservative therapy in 11 days time, while other developed collapse and empyema which required reoperation which resulted in lobectomy. This patient had prolonged hospital stay (42 days) but finally discharged in satisfactory condition. Six patients developed pneumonias, out of which three treated successfully with antibiotic therapy, other two patients (one following wedge resection and other had major lobectomy) of pneumonia later on went into ARDS, which ultimately proved fatal, both these patients had polytrauma having abdominal injury and long bone fractures respectively. Another case had tractotomy following gunshot trauma, he developed extensive pneumonia leading to septicemia and died of uncontrolled sepsis. Pneumonectomy patient had severe hemorrhage preoperatively and during operation, postoperatively he developed coagulopathy and multiorgan failure, which resulted in mortality.

Factors identified by univariate analysis as being significantly associated with mortality and morbidity were mechanism of injury, associated extrathoracic injuries, systolic blood pressure on arrival in operating room and increasing degree of pulmonary resection. Blunt injuries carries thrice the risk of mortality (33% vs 11.7%) as compared with penetrating trauma. Mortality was very high if systolic blood pressure was less than 90 mm of Hg (3 out of 4 mortalities was encountered patients having BP less than 90). Major resections had higher (16.6% vs 5.8%) incidence of developing ARDS. However, ARDS was also linked with need for laparotomy, extrathoracic injuries and the development of pneumonia in postthoracotomy period. Postthoracotomy pneumonia was identified independently as a risk factor for developing ARDS (2/6 pneumonias).

Discussion:

Only 10-15% of thoracic trauma patients will require thoracotomy and of these, up to 20% (or less than 3-5% of the total) requiring some form of major lung resection[6]. The perioperative mortality reported for lobectomy and Pneumonectomy when performed for traumatic lung injuries is unacceptably high. The studies have demonstrated that outcome depends on degree of shock, severity of pulmonary injury and presence of associated injuries[4,7]. The prolonged operating required for major anatomic resections may further contribute to patient's instability and potentially jeopardize the final outcome. This has served as an impulsion to look for quicker and less extensive resection techniques[8].

With this background, the concept of thoracic damage control, necessitating short and simple yet definitive procedures like tractotomy and other lung sparing operations, which have been used in above 85% of cases.[2,7] Pulmonary tractotomy was first described by Wall et al. in 1994, for injuries that are too big or deep to be handled by simple wedge resection. The technique involves dividing the lung tissue bridging the wound tract between the vascular clamps. The exposed tract in than inspected, point bleeders and air leaks are screwed with figure-of-eight 4/0 prolene. The lung tissue beneath the clamp is than oversewn and the clamps removed. The proposed advantages of these techniques are shorter operative time (10-15 minutes), minimal blood loss and preservation of lung parenchyma; all of these have been linked to reduce the mortality as compared with major pulmonary resections[5,8].

Although with experience the appropriate procedure is selected according to site or severity of injury, however if pulmonary tractotomy has failed to control bleeding or it is otherwise indicated, usually due to extensive peripheral injuries, early adoption to resection is indicated. Nonanatomic wedge resections can be a viable option in

such scenario[2,9]. Oversewing pneumonorrhaphy was used in two patients only, this technique has limited place in superficial lacerations that can be sutured or stapled without leaving a cavity behind.[2] The control of bleeding should not be the only goal but recognition and repair of bronchial leaks are equally important to avoid persistent air leak and bronchopleural fistulae. At the end of the procedure, the lung should be fully reinflated and carefully examined for recurrent bleeding, residual air leaks. If the air leak is large or there is failure of lung to expand, an operative approach my be indicated[7]

Another argument against the lung sparing surgery is large number of postoperative complications, as were also encountered in present study[5,10]. But fortunately the majority of complications are not of very serious nature and treatable with conservative measures, this is further reflected with marked reduction in mortality in lung sparing surgeries[2,11]. As a result of this improved outcome there has been remarkable change in the type operation for lung trauma, lung sparing techniques are gaining wide acceptance in place of traditional anatomical lobectomy[12]. The extensive use of stapler in these procedures has further added to the utility of these procedures. The rapidity in completion of the procedure is the main advantage for patients who are bleeding severely, which helps tremendously to reduce the number of complications[13].

Furthermore, about 25% of cases needed major resection (lobectomy or Pneumonectomy), the primary reason for this was more extensive lung injury or central location of the injury with involvement of larger vessels or bronchi[10]. Often a formal lobectomy or Pneumonectomy with standard control of hilar vessels is required. This can be technically demanding in such critical condition and especially in the presence of large perihilar haematoma. Apart from severity of injury, mechanism of injury and degree of physiological derangement, major resections were still associated with an increased risk of death.[9] It stresses the need to quickly assess whether lesser resection is possible option, if it becomes apparent that major resection is required then this should be performed without delay. It is established that increasing blood loss increase the mortality linearly, independent of other factors discussed above.[12,14,15]. This highlights that surgeon should be well verse with all techniques, specific anatomic injury and physiological state of patient should determine the approach rather than surgeon's acquaintance to the procedure.

Conclusion:

Although the majority of lung injuries can be managed with chest intubation, severe bleeding will require surgical intervention. Majority of pulmonary injuries can safely be managed by lung sparing surgical techniques, in particular pulmonary tarctotomy has gain wide acceptance. Furthermore the stapling devices facilitate and expedite the execution of these procedures. A small fraction will still need major pulmonary resection, which carries higher mortality but it is not prohibilitively high as to exclude their use when required. However, this accentuates the obligation for the surgeons involved in the management of thoracic trauma to be familiar with all possible required procedures, but not married to one.

Table 1 Preoperative Injury Characteristics and Physiologic data of patients

Characteristics	Pneumonorrhaphy (n=4)	Tractomy (n=7)	Wedge resection (n=5)	Lobectomy/Pneumonectomy (n=5)
ISS	11	14	18	19
SBP on admiss. (mmHg)	102	96	89	83
Lowest pH level	7.3	7.2	7.05	7.02
Lowest Arterial O2 Sat (%)	96	91	89	88

ISS = injury severity score SBP = systolic blood pressure

Table 2. Operative Procedures performed

Operation	No.	%age
Pneumonorraphy	4	17.3
Tractotomy	7	30.4
Segmental Resection	5	21.3
Lobectomy	4	17.3
Pneumonectomy	1	4.3
Bronchial Tear Repair	1	4.3
Ligation of intercostal A.	1	4.3

Table 3. Comparison of Outcome Parameters in two Groups

Parameters	Lung Sparing (n=16)	Major resection (n=5)	P-value
Days of Mech. Vent (A)	3	7	<0.05
ICU stay (A days)	5	8	NS
Days of chest int. (A)	7	11	<0.05
Hospital stay (A days)	13	21	<0.05

A = Average P < 0.05 = significant NS = Not Significant

Table 4. Complications Related to Lung Surgery

Complications	Lung Sparing n=16	Major Resection n= 5	P- Value
Pneumonia	4 (25.0%)	2 (40.0%)	< 0.05
Air Leak > 7 days	2 (12.5%)	0 (00.0%)	< 0.05
ARDS	1 (06.2%)	1 (20.0%)	< 0.05
Empyema	1 (06.2%)	0 (00.0%)	NS
Reoperation	1 (06.2%)	0 (00.0%)	NS
Septicemia	1 (06.2%)	0 (00.0%)	NS
MOSF	0 (00.0%)	1 (20.0%)	< 0.05
Overall Morbidity	7 (43.7%)	3 (60.0%)	< 0.05
Mortality	2 (12.5%)	2 (40.0%)	<0.05

Note: Multiple complications were seen in same patient.

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