

1-1-2012

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Recommended Citation

Sindhvananda, W and Luengtaviboon, K. (2012) "Surgical and anesthetic managements of an adultpatient with a giant mediastinal mass," *Chulalongkorn Medical Journal*: Vol. 56: Iss. 1, Article 6.
Available at: <https://digital.car.chula.ac.th/clmjjournal/vol56/iss1/6>

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Surgical and anesthetic managements of an adult patient with a giant mediastinal mass

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Sindhvananda W, Luengtaviboon K. Surgical and anesthetic managements of an adult patient with a giant mediastinal mass. Chula Med J 2012 Jan - Feb; 56(1): 61 - 9

A 22-year-old male with a giant anterior mediastinal mass underwent general anesthesia and tumor removal through Clamshell incision. The mass (approximately 4 kg) that occupied the plural cavity with retarded venous drainage of the chest caused the symptoms and signs of SVC obstruction. Due to no sign of upper thoracic airway obstruction, the operation plan was not included CPB standby. Anesthesia in this case was difficult from the beginning. However, it was smoothed out with subsequent intravenous thiopental induction, followed by atracurium and sevoflurane in maintenance of the anesthesia. During the operation, accidental tear of the right atrium occurred; controls of the cardiovascular stability were subsequently critical. In spite of this, the patient was finally saved and had rapid recovery after surgery. Postoperative pathological examination including microscopic examination revealed only benign component of germ cells viable in the specimen. All margins were free from the tumor. The patient was discharged 5 days after the operation.

Keywords: Mediastinal mass, airway compromise, CPB standby.

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Received for publication. February 15, 2011.

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วัชริน สินธวานนท์, กิตติชัย เหลืองทวีบุญ. กระบวนการผ่าตัดและระงับความรู้สึก ในผู้ป่วยที่มีก้อนในช่องอกขนาดใหญ่มาก. จุฬาลงกรณ์เวชสาร 2555 ม.ค. - ก.พ.; 56(1): 61 - 9

ผู้ป่วยชายอายุ 22 ปีที่มีก้อนเนื้ออกที่ช่องอกขนาดใหญ่มาก ที่เข้ารับการผ่าตัดเพื่อนำก้อนเนื้อออก โดยลักษณะของแผลผ่าตัดเรียกว่า *Clamshell incision* ขนาดก้อนเนื้อใหญ่มาก (น้ำหนักประมาณ 4 กก.) จึงเบียดและกดการไหลเวียนของโลหิต จนเกิดอาการ SVC Obstruction เนื่องจากก้อนเนื้อไม่ได้กดทางเดินหายใจในช่องอกส่วนบน แผนการผ่าตัดจึงไม่ได้ใช้เครื่องช่วยปอดและหัวใจเทียม การระงับความรู้สึกในผู้ป่วยรายนี้ จึงเริ่มจากนำสลบด้วยยา *thiopental* ให้ที่ละน้อยทางหลอดเลือด หลังจากใส่ท่อช่วยหายใจสำเร็จ ได้ให้การคงระดับการสลบด้วยยาหย่อนกล้ามเนื้อ *atracurium* และยาดมสลบชนิดระเหย *sevoflurane* โดยระหว่างการผ่าตัดเกิดอุบัติเหตุผนังหัวใจ *right atrium* ฉีกขาดทำให้ความดันโลหิตต่ำลงเป็นอย่างมาก ซึ่งได้รับการแก้ไข ในที่สุดผู้ป่วยปลอดภัยและฟื้นตัวอย่างรวดเร็วในวันรุ่งขึ้น ผลการตรวจพยาธิสภาพของชิ้นเนื้อพบว่าก้อนเนื้อมีลักษณะเป็น *germ cell* และไม่ใช่นิ่วร้าย ผู้ป่วยได้รับอนุญาตกลับบ้านในวันที่ 5 หลังการผ่าตัด

คำสำคัญ: ก้อนเนื้อในช่องอก, ภาวะทางเดินหายใจอุดตัน, เตรียมพร้อมเครื่องปอดหัวใจเทียม.

Germ cell tumor is not common in adults with mediastinal tumors.⁽¹⁾ In addition, non-seminomatous germ cell tumors are usually highly malignant; and, surgery is not the primary treatment.⁽²⁾ However, chemotherapy might reduce the tumor's size. Surgery is probably a symptomatic treatment of mass compression effects.

In this case, since tumor markers after chemotherapy became negative, a surgical excision of the residual mass was most likely beneficial. Because of the size of the mass, compression on the airway and the superior vena cava produced preoperative cardiopulmonary distress in severe degrees. A coordinated plan of surgery and anesthesia was important to save the patient.

Case Report

A 22-year-old, 49 kg, and male patient presented at the first admission a year ago with severe dyspnea and orthopnea. Investigations were performed, and a mediastinal mass with massive pericardial effusion was revealed. He was treated for symptomatic reliefs with pericardial effusion drainage. Pathological examination could then diagnose that the nature of mass was mixed germ cells type. A plan for further treatment of the patient was set. At the beginning of the plan, the patient received four courses of chemotherapy for six months. The tumor titers (alpha feto protein and beta HCG) became negative. After that, surgical removal of *en bloc* of mass might be effectively performed if the tumor decreased in size. Unfortunately, the tumor size did not decrease as expected. Severe respiratory symptoms were aggravated so that he presented at the second admission with severe orthopnea. He was comfortable

only in sitting or head-up with the right lateral position. He already had full clinical signs of SVC obstruction. A new CT scan was performed and showed a huge lobulated heterogeneous enhancing right mediastinal mass, sized 15 X 22 X 25 cm³. The right superior vena cava, right atrium, left atrium, right pulmonary veins, and other related structures were compressed (Figure 1 and 2). In spite of the compression of the heart, echocardiography confirmed good LV function and revealed moderate pericardial effusion and adjacent to the mass to the RV free wall. Laboratory investigations were found within normal limits, except for significant anemia (Hb = 8.7 g/dl) and a slightly increased INR (INR = 1.14). Surgical removal of the mass was scheduled after the patient gave his informed consent.

General anesthesia began after completing basic monitoring, invasive arterial pressure, and a central venous line was connected to an infusion tube containing dopamine solution. Positive ventilation via mask with 100% oxygen was attempted in order to assess the degree of difficult ventilation. After a few minutes of mask ventilation, the patient was more comfortable and could lay head down to 30 degree. Then, a dose 25 mg of ketamine was intravenously administered. Although the patient was completely calm from the given ketamine, the control ventilation via mask was done effectively. However, this effective ventilation was done with airway pressure at 40 cmH₂O. Intubation was then performed by direct laryngoscopy and facilitated by succinyl choline 1 mg per kg. Supplemental thiopental dose of 50 mg was given three times during a waiting period of profound relaxation because the patient was not fully unconscious. Furthermore, it would not be harmful since



Figure 1. A preoperative Chest study revealed haziness area of the occupying mass also the heart in the two-third of lower lungs.



Figure 2. A longitudinal CT study revealed the mass position was on the right chest compressing the heart. The lower trachea and the main bronchus were still preserved. (an arrow)

effective ventilation could be established in spite of increasing relaxation from a given dose of succinylcholine. Due to a good Mallampati class, the airway was secured in a few seconds with 8.0 mm cuffed endotracheal tube (a mark of 20 cm at the upper lip). After finishing intubation, the ventilation was then reassessed in order to settle the proper depth of anesthesia also mode of ventilation. In a trial of positive ventilation via endotracheal tube, capnograph showed a pattern of alveolar-reached ventilation with high end-tidal CO₂ approximately 40 - 55 mmHg and the airway pressure slightly increased; they were in the acceptable ranges. Atracurium 15 mg was then given to facilitate the surgical condition. In total, the amount of atracurium was 35 mg. The depth of anesthesia was maintained with 100% oxygen and 1-2% sevoflurane; and fentanyl 50 mcg was given during the late period of the operation. In the early maintenance period, blood pressure was around 80/40 mmHg. Dopamine infusion was started to facilitate hemodynamic stability. Blood and blood components were prepared for prompt transfusion whenever

needed. Continuous bleeding was started at the moment of dissection of the tumor from the adjacent structures. The amount of volume was carefully replaced in time for substituting the blood loss. Unfortunately, the right atrium was accidental torn, and a lot of blood loss and low blood pressure suddenly occurred. The mean arterial pressure went down to 40 - 50 mmHg.

As for the surgical procedure, a Clamshell incision was made. The right chest was firstly explored, and then the tumor was freed from the right lung. Some part of the pericardium was excised with the mass. The right phrenic nerve was preserved. Next, the superior aspect of the mass was mobilized including the left innominate vein, which it was excised a part that attachment of the mass. Later, the mass that was compressing the left lung was removed. As for the rest, the mass that attached to the right atrial wall was so firmly fixed. Fortuitously, during the dissection, the right atrium was torn.

Continuous rapid fluid and blood replacement were found to obscure the repair of the right atrium.

In spite of the low blood pressure, fluid replacement was stopped for a moment. Subsequently, the repair of the right atrium was complete a minute later.

After finishing the right atrium repair, though volume replacement had been sufficiently given, the mean arterial pressure was around 40 - 50 mmHg. Adrenalin was then a top-up to control the blood pressure, which it could be maintained in the acceptable level until finishing operation (mean arterial pressure > 60 mmHg). The other cardiopulmonary parameters were also within normal limits. An approximate total blood loss was as much as 10 L. The duration of the operation was approximately 4 hours.

Postoperatively, the patient was intubated and transferred to ICU. In the ICU, the hemodynamic status was rather stable. Inotropes were gradually weaned and off within 6 hours. He was extubated in the following morning. There was a significant improvement in the chest radiograph (Figure 3). He was discharged home 5 days later.



Figure 3. A postoperative CXR study (Day 1) revealed the normal heart size, the right elevated diaphragm and satisfactory lung expansion.

Discussion

Anesthetic management

Despite an anesthetic plan was set to avoid severe hypotension and hypoxemia^(3,4), it was difficult to manage as planned. Since the patient strongly refused to lie down or only agreed to move a bit head down, and he tried to continue staying right-sided down although oxygen supplement was changed to oxygen mask with bag 10 LPM., the patient's position might not be suitable for peripheral and central IV accesses. Therefore in this case, compromises had been taken into consideration by completing IV accesses and arterial accesses as quickly as possible at the left femoral area. However, the other femoral area should be left and prepared for surgical access of femorofemoral bypass.^(3, 5-7)

As for the most important concern -ventilation security-airway obstruction was the first priority of concern since it could cause fatality. The incidence of airway obstruction with the use of GA was sporadically reported in case discussion. However, there was a review in 1994 the incidence was 7 to 18%.⁽⁸⁾ It should be noticed that this report of incidence as well as many case reports of airway obstruction were in pediatric patients. Interestingly, a cohort study of 105 adults of mediastinal mass reported no event of airway obstruction from total 97 cases receiving general anesthesia.⁽⁹⁾ More striking, it was summarized that most patients received general anesthesia with muscle relaxants (94 in total 105 cases or in 97 cases of GA). Therefore, these evidences imply that anesthesiologists should not overemphasize airway obstruction in adult patients so that the chosen techniques would avoid airway obstruction that might cause other uneventful outcomes.

Misunderstanding of 'airway obstruction/airway compromise' leads to apply improper anesthetic techniques. To avoid this confusion, in the common term of 'airway obstruction/airway compromise' should be replaced by '(alveolar) ventilation compromise'. The 'ventilation compromised' refers to a component of abnormality in anatomical airways together with a component of dysfunctional mechanic of breathing/ventilation. Regarding the abnormality of anatomical airways, fatal airway collapses induced by a mediastinal tumor is an extrinsic compression on large airways (the lower trachea and the main bronchus).⁽⁵⁾ In adding to effects of GA, relaxation of the tracheobronchial smooth muscle enhances airway compromise with the extrinsic compression but on smaller airways.⁽¹⁰⁾ It should be noted that these airway compromise mainly claimed for intrathoracic airways (below main bronchus), so this effect should be a dysfunctional mechanic of breathing/ventilation.⁽¹¹⁾ Therefore in a high severity of 'mechanic of breathing' dysfunction, managements regarding upper airway obstruction, such as awake intubation and LMA, should not be suitable in those patients who supposed to have only the 'mechanic of breathing' dysfunction.

Therefore, the real matter of concern should be the 'dysfunction in the mechanism of breathing'. It is noteworthy that, patients normally need being anesthetized during surgical procedures. Thus, the effects of GA on muscle relaxation previously mentioned absolutely existed throughout the anesthetized state. A decrease in the lung volume during GA subsequently produces poor lung compliance this means in spite of ventilation with a higher positive pressure does not confirm adequate

alveolar ventilation.^(11,12) As a result, the necessary management in case of those lower airway compromise should be a provision of adequate alveolar ventilation under a high airway pressure than a focus on fatal airway collapses.

Some investigations attempted to state parameters for the prediction of airway compromise caused by GA.⁽¹⁰⁾ In previous studies, 'superior mediastinal syndrome'(S/Sof SVC_obstruction),⁽¹³⁾ decrease in trachea diameter > 50% (on CT examination),⁽¹⁴⁾ mediastinal thoracic ratio > 50% (MTR =size of mass/size of thoracic diameter),⁽¹⁵⁾ mediastinal mass ratio > 45% (MMR= maximum width of mass/maximum width of the mediastinum by CT scan),⁽¹⁶⁾ and abnormal flow volume loop.⁽¹⁷⁾ All of these are mentioned as the warning signs of possible respiratory complications. Again, almost all of them were in studies in pediatric patients, except_for the abnormal flow volume loop that was also investigated in adults. Unfortunately, these indications did not prove for their specificity to predict airway compromise.^(9,10)

However in practice, patients who have compressions of trachea or large bronchus on CT study should be first indentified.⁽⁵⁾ Awake fiberoptic bronchoscopy assisting intubation should be useful in this group of patients. On the contrary, the patients who have no compression of the trachea or main bronchus, induction of anesthesia can be attempted with careful assessment of the security of alveolar ventilation.⁽¹⁰⁾

Regarding the anesthetic drugs, two important concerns are that they should not cause serious hypotension and airway compromise. Thus, inhalation induction has been recommended in several previous

reports predominately based on pediatrics.^(1,8,18) It might not be the safest technique, especially in adults. As for the supportive reasons, the pathology should either be categorized into the main airway compression (lower trachea and bronchus) or no main airway compression. As for the former, inhalation induction for intubation might be harmful. Because a higher lung volume than that of pediatrics, a longer induction time is therefore needed for the appropriate state of intubation. As the pathology in the main airway obstruction interfere a significant degree of alveolar ventilation, which can cause a large amount of secretion in a situation of being excitement state, some degree of laryngospasm can occur. Thereafter, stop continuing inhale anesthetics and waiting for the lighter state of anesthesia are recommended as a solution.^(18, 19) But in real situations, it should aware that a lightened state of anesthesia might not be quickly reached due to diminishing inhale anesthetics outflow by the pathology. Intubation at this crisis in adults might not be successfully and quickly as much as in pediatrics due to the more muscle power. Thus, a serious hypoxemia still occurs so that it later causes fatal cardiovascular conditions. Eventually, anesthesiologists are confronted with awful situations that are a few times left for airway security and resuscitation. In brief, inhalation induction might not be safe in patients with lower airway compromises.

In addition, too much avoidance of muscle relaxants might induce difficult intubation. Hypercarbia that occurs following a long moment of attempts might cause a significant increase of pulmonary resistance, which then will aggravate poor alveolar ventilation on top the abnormal lung mechanic that caused by the mass. Positive ventilation is

recommended to be avoided because spontaneous breathing can bring about the better alveolar ventilation also the better maintenance of blood pressure.⁽¹⁰⁾ However, a given anesthetic depth with no neuromuscular blockade should be kept more profound than that with neuromuscular blockade. Deeper of anesthesia can cause more cardiovascular depression. Therefore, muscle relaxants should not be tried to avoid in all patients with a mediastinal tumor.

In sum, anesthesiologists should meticulously review all aspects of risks and benefits to each patient. Moreover, anesthesiologists should move beyond theoretical risks and benefits by carefully attempt under good plans. In so doing, the attempts of positive ventilation should be done before deciding to give muscle relaxant. These attempts revealed no serious cardiovascular depression and satisfactory ventilation, Therefore, the plan to keep the patient unconscious and giving muscle relaxants could be followed. Consequently, good surgical conditions were achieved through operation so that the patient would benefit from better surgical approach. Interestingly, these attempts could reveal some cloudy theory-based risks and benefits.

Surgical management

The patient was operated under a Clamshell incision because the tumor was in the lower part of the anterior mediastinum occupying the pleural and retrosternal spaces. A traditional incision, median sternotomy, was possibly adequate for removal of most part of the tumor in the right pleural space.

Regarding the standby CPB, its risks and benefits should be thoroughly considered through realization of the possibility of airway compromise.

This can easily be disclosed by careful evaluation on CT studies; for example, a large airway compression by the mass, especially when its position is anterior to the main airways. This can cause serious airway obstruction during the anesthetic procedures. More importantly, a consideration of overemphasizing airway compromise and a better cardiovascular control should not be the only issue taken into account so that surgeons ignore risks of CPB, such as an increase blood loss due to heparin effects, a high possibility of bleeding in airways due to surgical manipulations,⁽²⁰⁾ and a high possibility of longer ventilator support.^(20, 21) In addition, systemic inflammatory responses, a severe adverse effect of CPB, might enhance serious conditions in patients with malignancy.⁽²²⁾ However, in evidence of preoperative large airway compression, femorofemoral bypass should be used.

Conclusion

Dealing with a huge anterior mediastinal mass in adults is a challenge for surgical and anesthetic teams. As security of alveolar ventilation is vital. Therefore, understandings of the mechanism of airway compromise together with a careful examination of mass position should be clarified. A high possibility of airway compromise is found in situations when the mass is located anterior to main airways, in which CPB should be considered. Concerns for risks of CPB, especially regarding patients' postoperative conditions, should be taken into considerations. Also, surgical and anesthetic plans should be well coordinated.

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