
KINGSTON HEALTH SCIENCES CENTRE

CHEST TUBE REMOVAL:

Removal of a Pleural or Mediastinal Chest Tube

**Kingston Health
Sciences Centre**

Centre des sciences de
la santé de Kingston

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This learning guide has been developed by
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NOTE: This learning guide contains information that is current at the time of publication and distribution. Policies and procedures are reviewed regularly and change frequently. Please refer to related policies and procedures on the Intranet.

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1 INTRODUCTION

Chest tubes restore negative pressure between the pleural and visceral cavities and allow re-inflation and full expansion of the lung. Chest tubes are removed when they are no longer needed to remove air, blood, fluid, or purulent exudate from the intrapleural or mediastinal space. Prior to chest tube removal it is recommended the following criteria are assessed by the Prescriber and should be met:

1. Respiratory status has improved (i.e. non-laboured respirations, equal bilateral breath sounds, absence of shortness of breath, no use of accessory muscles, symmetric respiratory excursion), and the respiratory rate is normal.
2. Intrapleural negativity has been re-established (i.e. fluctuations in the water-seal chamber are minimal or absent).
3. Air leaks have resolved.
4. Drainage amount is at a satisfactory level for the given condition and as per the prescriber.

When the criteria for removal are met or at the prescriber's discretion, the order to remove the chest tube is written. If the chest tube is on suction it may be trialed to a water seal (straight drainage) first. Only authorized Regulated Healthcare Professionals (RHCP) can remove mediastinal and pleural chest tubes. If a pigtail chest tube or PleurX™ catheter is present it will be removed by the prescriber.

The types of sutures that secure chest tubes vary. There is always at least one *stay suture*, which anchors the chest tube in place. In addition, *purse string closing suture* may be inserted into the skin during chest tube placement. This allows closure of the insertion site when the chest tube is removed (see Figure 1). The purse string closing sutures are distinguishable from the stay suture as they are longer and different in colour, typically teal.

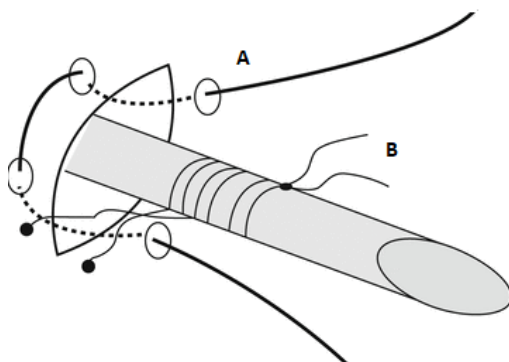


Figure 1: Chest tube with a stay suture and purse string closing suture. **A.** Purse string closing suture (usually a different colour and if also wrapped around the chest tube sits higher than the stay suture). **B.** Stay suture (wrapped around chest tube and there could be two to anchor each side).

2 Authorization Process

The information contained in this learning guide will prepare you for removal of chest tubes. Chest tube removal is an added skill at KHSC. RHCP's who successfully complete the defined organizational knowledge and skill evaluation may remove chest tubes and tie the purse string closing suture (if applicable).

To obtain the skill in removal of chest tubes the RHCP must:

1. Review the learning guide on chest tube removal.
2. Achieve a minimum score of 80% on the competency test.
3. Demonstrate safe chest tube removal supervised by the Clinical Learning Specialist or delegate with completion of the skill evaluation (See Appendix A: Removal of a Chest Tube).

Tying purse string closing sutures are an additional authorization to chest tube removal. To obtain the skill in tying purse string closing sutures for chest tube removal the RHCP must:

1. Be authorized for chest tube removal
2. Perform a practice demonstration with the CLS or delegate
3. Demonstrate tying of a purse string closing suture supervised by the CLS or delegate with completion of the skill evaluation (See Appendix B: Tying of Purse String Closing Sutures with Chest Tube Removal).

3 Expected Competencies of the Learner

Upon authorization for the added skill of Chest Tube Removal, the RHCP will meet the following competencies:

1. Conduct a thorough nursing assessment of a patient who has either a mediastinal or pleural chest tube and assess criteria for removal (lung re-expansion, resolution/absence of an air leak, and decreased fluid drainage).
2. Confirm the presence of a written prescriber's order.
3. Remove a chest tube(s) and apply appropriate dressing(s).
4. Assess for the presence of a purse string closing suture and if applicable, with another RHCP appropriately tie off the closing suture.
5. Conduct a thorough nursing assessment of a patient following chest tube removal (i.e. auscultating for breath sounds bilaterally and assess for any complications).
6. Document procedure, any changes to patient status and communicate concerns to the prescriber.

4 DEFINITIONS

Fluctuation/Tidaling: A normal gentle rocking of fluid in the chest tube water-seal system, indicating that the system is functioning properly. There is no fluctuation in the mediastinal drainage system because the tube is not placed in the lung cavity and therefore does not reflect intrapleural changes.

Occlusive Dressing: An air- and water-tight dressing. Occlusive dressings consists of paraffin based gauze (i.e. Jelonet™) and 4x4 gauze reinforced with abdominal pads and self-adhesive tape, which closely form to the skin surrounding the insertion site preventing passage of air or fluid.

Purse-string closing suture: A suture that circles around the chest tube under skin and is pulled tight when chest tube is removed to close the insertion site. Often a different colour and sits higher on the tube than the stay suture.

Stay suture: Sutures that are utilized to hold the chest tube in place. There can be one or two (one on each side) depending on how the prescriber has anchored the chest tube.

Subcutaneous Emphysema: The presence of free air or gas in the subcutaneous tissues. Often described as feeling like “Rice Krispies” under the skin.

Suction: Drainage via a chest tube is usually more effective when gravity and the suction source are combined to move fluids or air out of the pleural space. Suction for chest tubes is generally measured in cmH₂O. The wall suction is measured in mmHg. These two measurements are not equal; use caution. Normal pressure for chest tubes are -15 to -20cmH₂O and may go as high as -40cmH₂O. Straight drainage is equal to -8 cmH₂O (normal physiologic intrapleural pressure).

Water seal: The basic purpose of the chest tube is to allow the re-establishment of the negative intrapleural pressures by allowing air and fluids to escape. The chest tube, however, may also be a site to allow air to re-enter the pleural space, if it is left open to air. To prevent this from occurring, the distal end of the tube is placed underwater. This creates a one-way valve allowing air to escape, but prevents it from re-entering the patient's chest. Atmospheric air cannot enter the tubing because of the water barrier. This is called a water seal.

5 OVERVIEW OF ANATOMY AND PHYSIOLOGY OF RESPIRATORY SYSTEM

5.1 Anatomy

Pleurae and Pleural Space

Each lung is covered with two thin layers of serous membrane, collectively called the pleurae. The inner layer, the **visceral pleura**, covers the surfaces of each lung, as well as the fissures between the lobes. It is inseparably attached to the lung surface. The **parietal pleura** covers the internal surface of the thoracic wall, the lateral surface of the mediastinum, the superior surface of the diaphragm, and the lung apices.

Both the visceral and parietal pleurae have a blood supply and a lymphatic supply through which they secrete and absorb fluid. The surfaces of the visceral and parietal pleurae are moistened by minimal amounts of serous fluid, defined as pleural fluid. The potential space between the visceral and parietal pleurae is termed the **pleural cavity** or pleural space. This pleural space is called a 'potential' space because it has the capacity to hold a large amount of fluid.

One to two litres of fluid moves across the pleural space each day, but because the fluid is constantly being secreted and absorbed, only 10 - 20mL of the pleural fluid remains in the pleural space at any one time. The pleural fluid lubricates the pleural surfaces as they move against each other as the lung size expands and recoils with inspiration and expiration.

Diaphragm

The diaphragm is the main muscle of respiration. It stretches across the bottom of the thorax, separating the thoracic cavity from the abdominal cavity. During inspiration, the diaphragm contracts and moves downward, increasing space within the thoracic cavity to allow for lung expansion. During expiration the diaphragm retracts, decreasing the volume in the thoracic cavity.

Mediastinum

The mediastinum lies in the middle of the thorax between the lungs, and between the sternum and the vertebrae. These structures are all contained within their own viscera. The diaphragm forms the inferior border of the mediastinum. The contents of the mediastinum include the heart, aorta, thymus, vagus and phrenic nerves, esophagus, trachea, lymphatic, nodes and numerous other vessels.

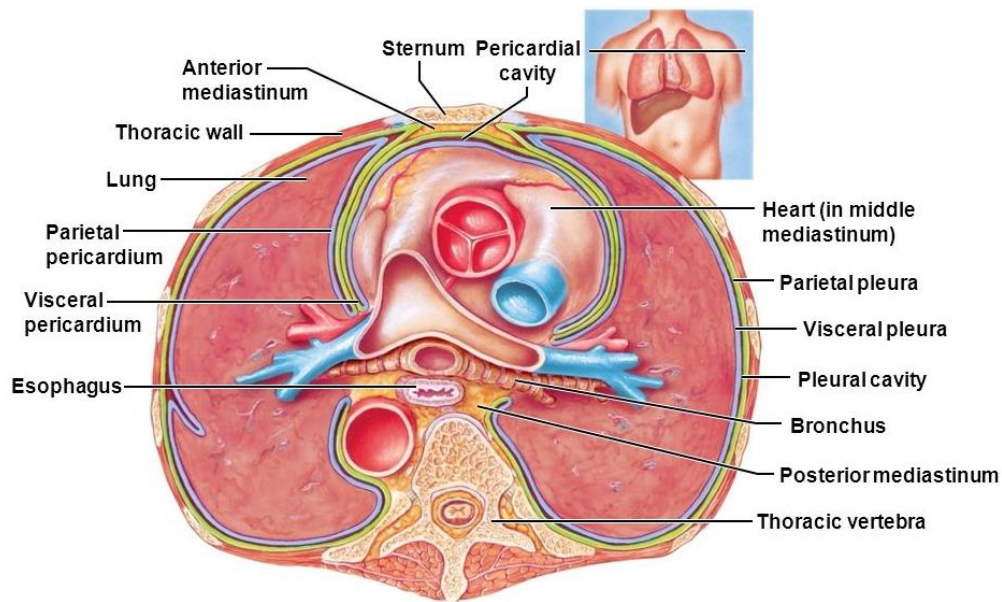


Figure 2: Transverse View of the Thorax Illustrating Pleurae and Lungs

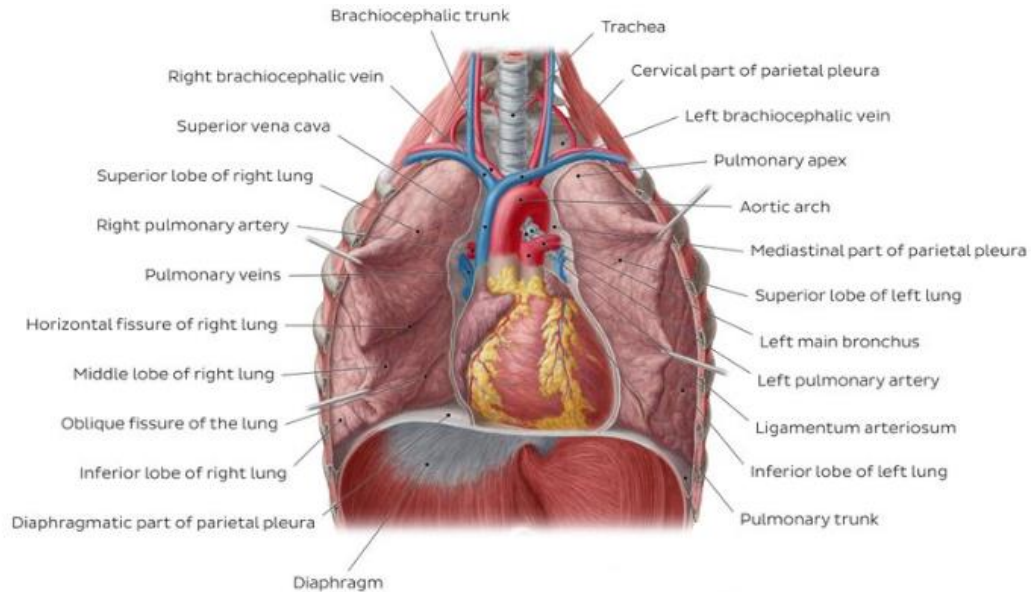


Figure 3: Anterior view of the thoracic cavity

5.2 Physiology

Air moves in and out of the lungs based on pressure changes. The diaphragm contracts and moves downward and the external intercostal muscles move the rib cage up and out. The lungs expand because of the movement of the diaphragm and the chest wall. The surface tension of the pleural fluid holds the pleurae together, thus preventing the lungs from collapsing.

As the chest wall expands the parietal pleura moves, pulling the visceral pleura, and the lung along with it. This increases the volume within the thorax and decreases the lung pressure and is defined as intrapulmonary pressure. The volume change in the thorax makes the pulmonary pressure lower (-2 mmHg) than the atmospheric pressure (0 mmHg). Air flows into the lungs because of this pressure gradient. This is inhalation or inspiration.

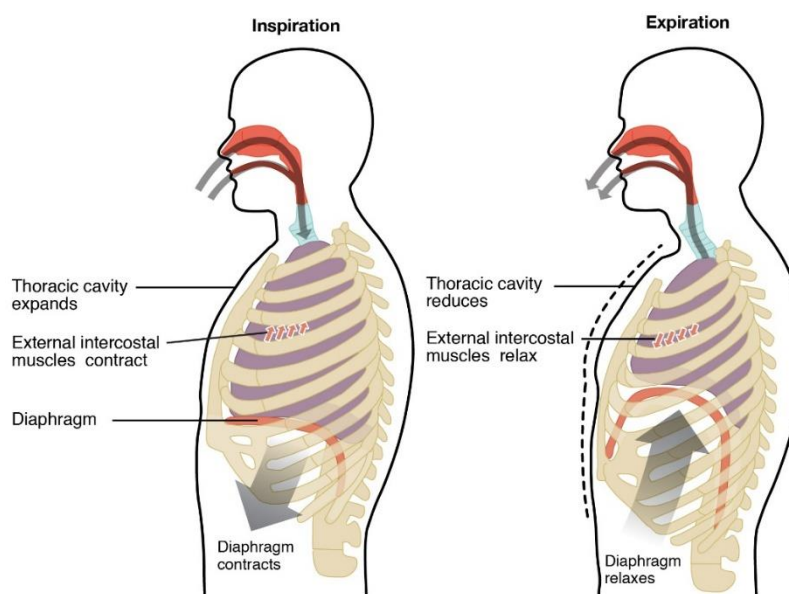


Figure 4: Inspiration and Expiration of the Lung

When the diaphragm returns to its normal, relaxed state, the intercostal muscles also relax and the chest wall moves in. The lungs, with natural elastic recoil, pull inward. This is called exhalation.

The negative pressure between the pleurae maintains partial lung expansion by keeping the lung pulled up against the chest wall. Under normal conditions, there is always negative pressure within the pleural space. This is known as intrathoracic or intrapleural pressure. The intrapleural pressure degree of negativity will change throughout respiration (-5 mmHg to -8 mmHg during inspiration). If the patient takes a deeper breath, the intrapleural pressure will be increasingly negative, > -8 mmHg.

If air is introduced into the pleural space, this intrapleural negative 'pull' is lost and the lung collapses (pneumothorax).

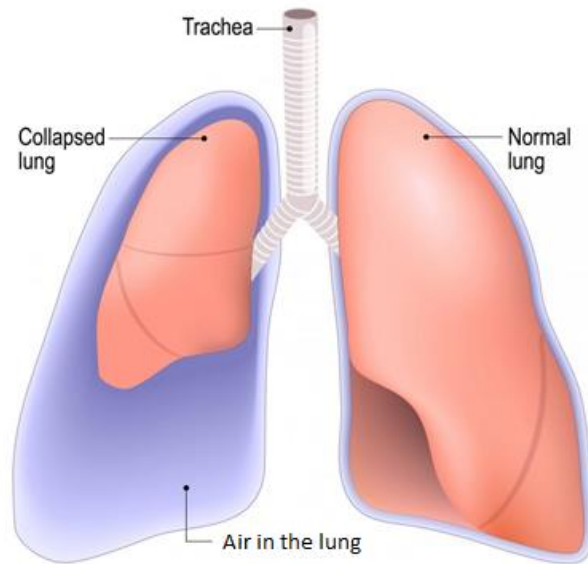


Figure 5: Pneumothorax

6 PLEURAL AND MEDIASTINAL CHEST TUBES

Blood/fluid moves through the tubing when pushed along by fresh drainage behind it and/or assisted by suction. Because of the long transit time, the tubing may become filled with clots resulting in drainage obstruction. Careful attention to the chest tube drainage is required. Chest tubes can be connected to a closed chest tube drainage system (such as a Pleur-evac® or Thopaz⁺ Digital Chest Drainage and Monitoring System). See policy KHSC Clinical Policy C-2870 Chest Drainage (Closed) for more information on closed chest drainage systems.

6.1 Location of Chest Tubes

Chest tubes are classified according to the location into which they are inserted, pleural or mediastinal, and the rationale or underlying etiology for insertion.

Pleural Chest Tubes

Pleural chest tubes are inserted into the anterior chest area, anterior to the mid-axillary line to prevent the patient from lying on the tube.

To drain air from a pneumothorax, pleural tubes are placed in the lung apex at the second and third intercostal space (ICS) and mid-clavicular line (MCL). Occasionally, the location of a tube to drain air is located in the fourth ICS in the mid (MAL) to anterior axillary line (AAL).

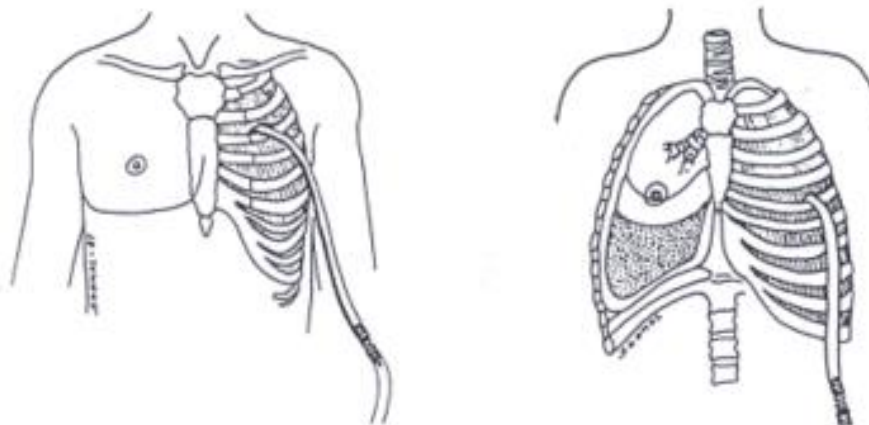


Figure 6: Chest Tube Placement

To drain fluid, for example, a hemothorax, empyema, post-operative drainage, or pleural effusion, the tube is placed in the lateral chest area at the fifth or sixth ICS, AAL and as low as the eighth or ninth ICS, MAL. Once the tube is in situ, the tip of the tube is advanced several inches into the pleural space along the surface of the lung.

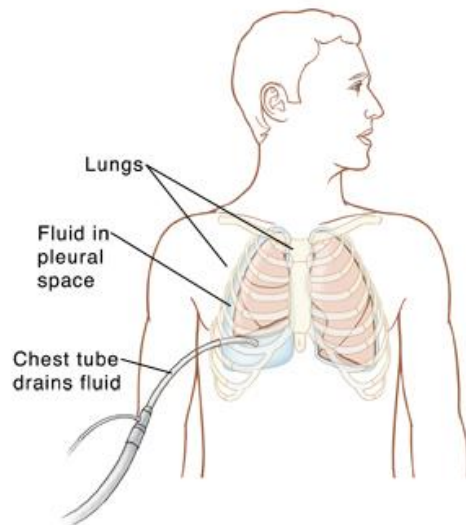


Figure 7: Pleural Chest Tube in Placement

Following lung surgery, two pleural chest tubes are usually used. One is directed anteriorly to remove air; the other is directed posteriorly through a lateral incision to drain fluid. The tubes are placed in the pleural space, through a puncture wound, two or three ICS's below the surgical incision.

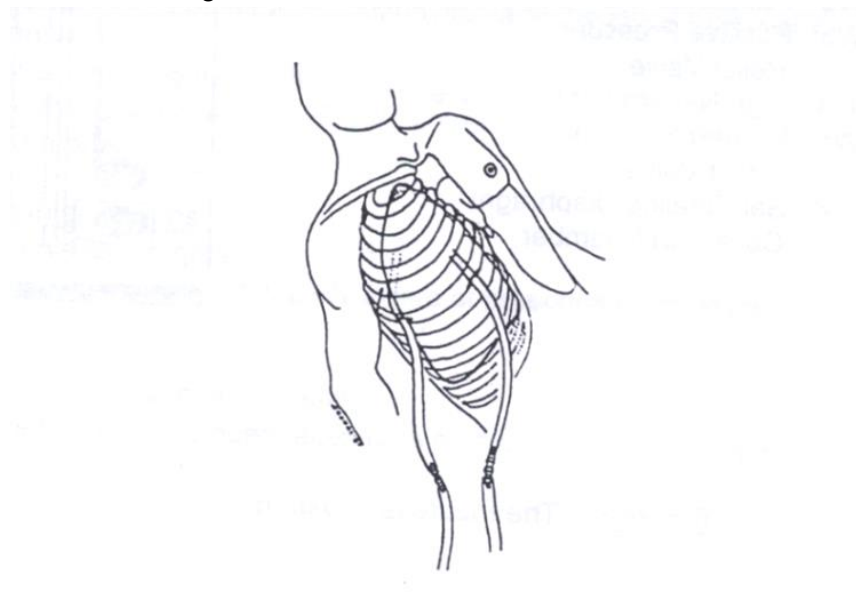


Figure 8: Two Pleural Chest Tubes in Position

Mediastinal and Pericardial Chest Tubes

Mediastinal chest tubes, including pericardial chest tubes, are inserted just before chest closure during cardiac surgery to facilitate fluid drainage from the mediastinal space. They function to drain the mediastinal space and to assist with lung re-expansion, if a surgical procedure, heart or lung related, extended into the pleura of the lung.

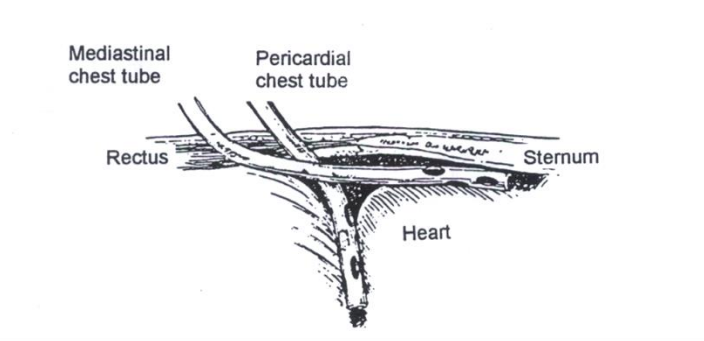


Figure 9: Mediastinal and Pericardial Chest Tubes

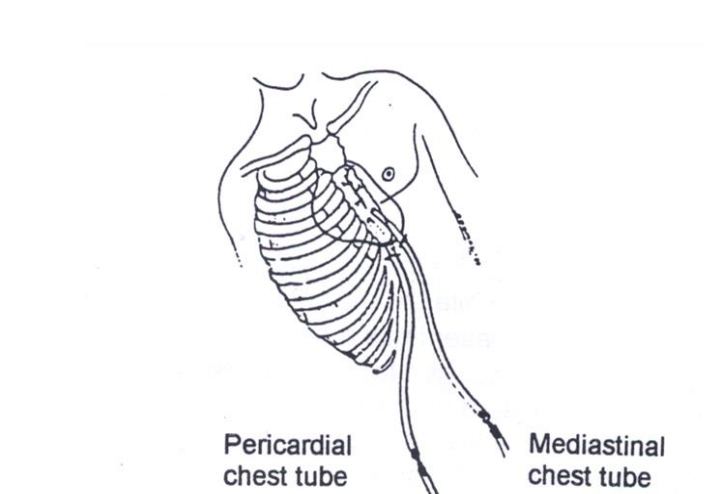


Figure 10: Mediastinal Chest Tubes in Position

7 CONTRAINDICATIONS FOR CHEST TUBE REMOVAL

Prior to chest tube removal the previously noted criteria should be met (i.e. improved respiratory status, re-established intrapleural negativity, drainage <450ml in 24hrs or at the Prescribers discretion and resolved air leaks). The RHCP must ensure that no changes have occurred since the Prescribers order to remove the chest tube that would otherwise contraindicate chest tube removal. If changes are noted since the Prescribers order, notify the Prescriber.

7.1 Air Leak Assessment

An air leak occurs when air enters the patient's chest tube drainage system. The leak can begin as very small, and progress to a larger leak. The RHCP should assess for air leaks on the initial patient assessment. This would be a contraindication for removal of the chest tube unless ordered different by the Prescriber. Notify the Prescriber of any change.

Note: When two chest tubes occupy the same pleural space and one has an air leak present the other tube may be removed.

Pleur-evac® Closed Chest Drainage System

The RHCP will assess the following with the Pleur-evac® Closed Chest Drainage System:

- Assess the leak by watching the underwater seal chamber with the patient taking deep breaths and coughing, while the patient is on and off suction (if applicable).
- Notify the Prescriber if a patient has a new air leak indicated by bubbling in the chamber.
- Assess for increase in size if a leak is not new and notify the Prescriber of any change. This is indicated by the 6 chambers in the underwater seal of a Pleur-evac® system. As a leak gets larger, the bubbling will begin to progress from the first chamber to the sixth.

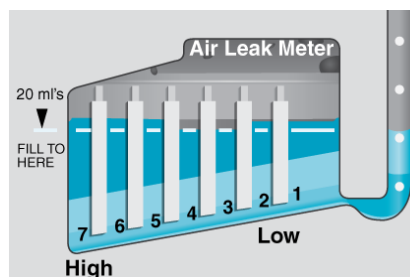


Figure 11: The Pleur-evac® Closed Chest Drainage System

Thopaz⁺ Digital Chest Drainage and Monitoring System

The RHCP will assess the following with the Thopaz⁺ Digital Chest Drainage and Monitoring System:

- The Thopaz⁺ Digital Chest Drainage and Monitoring System will quantify the air leak in mL/min on the main screen of the device. This can be trended over a 12h/24h timeframe.
- It is expected that there is a small air leak i.e. 0 - 50ml/min. A quantity of 0ml/min may indicate that the tubing is clamped or clogged.



Figure 12: Thopaz⁺ Digital Chest Drainage and Monitoring System

8 REMOVAL OF A PLEURAL OR MEDIASTINAL CHEST TUBE

Supplies Needed

Sterile dressing tray	<u>Occlusive dressing(s)</u>
Sterile scissors	Sterile gauze 4x4 (4 packages per chest tube)
Chlorhexidine 2% or Chlorhexidine 2% and Alcohol 70% (solution or swab)	Paraffin based gauze (e.g. Jelonet™)
Linen saver pad	Abdominal pad
Personal protective equipment (PPE)	Self-adhesive non-woven tape (e.g. Ultrafix®)
Gloves (Clean and Sterile)	

8.1 Procedure A: Removing a Pleural or Mediastinal Chest Tube without a Purse String Closing Suture

1. Review and verify patient care order and the correct patient by using two patient identifiers (see Administrative Policy 13-010 Patient Identification).
2. Assess if there are any changes to the patient status since prescriber's order that would contraindicate removal (e.g. new air leak, change in respiratory status, and increased output).
3. Provide patient education on the procedure and on any reportable symptoms post removal.
 - 3.1. Explain the procedure to the patient and practice exhaling techniques (i.e. Valsalva).
 - 3.2. Encourage patient to report any unusual symptoms such as sharp, sudden pain, shortness of breath or difficulty breathing after chest tube removal.
4. Position the patient in low semi-fowlers or on the unaffected side.
Rationale: *This allows for adequate viewing of the chest tube insertion sites and is most comfortable for the patient.*
5. Turn the chest tube suction off, if applicable.
 - 5.1. Do not clamp the chest tube, unless ordered by the prescriber.
Rationale: *Turning the suction off decreases resistance when removing the chest tube(s). Clamping the chest tube increases intrathoracic pressure, unnecessarily.*
6. Perform hand hygiene and don clean gloves.
7. Open the sterile dressing tray, suture set and prepare the occlusive dressing.
Rationale: *The dressing must be occlusive after removal to prevent air from entering the patient's chest via the chest tube insertion site. This prevents a pneumothorax.*
8. Remove the dressing and tape or securement device without exerting tension on the tube(s).
 - 8.1. Assess the site and notify the Prescriber of any signs of infection.
9. Remove gloves, perform hand hygiene and then apply sterile gloves.
 - 9.1. Don any additional personal protective equipment required as per point of care risk assessment.

10. Cleanse the chest tube insertion site with Chlorhexidine 2% or Chlorhexidine 2% and Alcohol 70% (solution or swab) and allow to air dry completely.
Rationale: *To prevent infection when tube is removed.*
11. Clip and remove the stay suture.
 - 11.1. Cut the suture closest to the patient and pull from the knot.
 - 11.2. Ensure the entire suture has been removed from the patient.**Rationale:** *Eliminate risk of infection by not pulling through exposed suture. Leaving a piece of suture will increase risk for infection.*
12. Loosely apply the occlusive dressing over the chest tube insertion site(s); paraffin based gauze, 4X4 gauze (x4) per chest tube, abdominal pad and self-adhesive non-woven tape.
13. Instruct the patient to take three deep breaths, hold the third one, and perform the Valsalva maneuver or alternatively take a deep breath and hum.
 - 13.1. Explain to the patient they will need to hold their breath or hum until the chest tube is removed and dressing secured.
 - 13.2. If the patient is unable to obey commands or is on positive pressure ventilation via an endotracheal tube, remove the chest tube(s) at the beginning of exhalation, just at the end of inspiration.**Rationale:** *Prevents a pneumothorax from air entering the pleural space as the chest tube is being removed. Having the patient hum gives audio confirmation that the patient is exhaling. Otherwise they could be taking a breath in silently.*
14. Remove the chest tube(s) in a swift downward motion.
NOTE: If there is strong resistance with removing the tube stop the procedure, cover the site with an occlusive dressing and notify the Prescriber immediately.
Rationale: *The tube may have inadvertently been sutured during surgery or is twisted.*
15. Apply the dressing simultaneously as the tube is removed.
 - 15.1. Instruct the patient to breathe after the tube is out and when you have covered the site.
 - 15.2. Secure the dressing with self-adhesive non-woven tape.
16. Assess the patient for any changes in respiratory status immediately post removal.
17. Assess the chest tube prior to discarding to ensure there was no fracture in the tube upon removal.
 - 17.1. Consult the Prescriber immediately if a portion of the tube remains in the patient.**Rationale:** *A piece of tube left inside the patient will require surgical removal.*
18. Discard supplies, remove PPE and perform hand hygiene.
19. Obtain chest x-ray if ordered.
20. Before disposing of the drainage system ensure ports are sealed and disposed of in biohazard waste.
Rationale: *To ensure no leakage when discarded.*

8.2 Procedure B: Removal of a Pleural or Mediastinal Chest Tube with a Purse String Closing Suture

Note: This is an additional authorization to chest tube removal. Removal of a pleural chest tube with a purse string closing suture must be carried out by two RHCP: one must be authorized in tying a purse string closing suture. Authorization by the Clinical Learning Specialist or delegate is utilized to determine if the RHCP possesses the knowledge, skill and judgment to safely tie a purse string closing suture.

1. Review and verify patient care order and the correct patient by using two patient identifiers (see Administrative Policy 13-010 Patient Identification).
2. Assess if any changes to patient status since Prescribers order that would contraindicate removal (e.g. new air leak, change in respiratory status, and increased output).
3. Provide patient education on the procedure and on any reportable symptoms post removal.
 - 3.1. Explain the procedure to the patient and practice exhaling techniques (i.e. Valsalva).
 - 3.2. Encourage patient to report any unusual symptoms such as sharp, sudden pain, shortness of breath or difficulty breathing after chest tube removal.
4. Position the patient in low semi-fowler or on the unaffected side.
Rationale: This allows for adequate viewing of the chest tube insertion sites and is most comfortable for the patient.
5. Turn the chest tube suction off, if applicable.
 - 5.1. Do not clamp the chest tube, unless ordered by Prescriber.
Rationale: Turning the suction off decreases resistance when removing the chest tube(s). Clamping the chest tube increases intrathoracic pressure, unnecessarily.
6. Perform hand hygiene and don clean gloves.
7. Open the sterile dressing tray, suture set and prepare an occlusive dressing
NOTE: A dressing is NOT required for purse string closing sutures if tied correctly.
Rationale: The dressing will only be utilized if there is improper closure of the purse string closing suture.
8. Remove the dressing and tape or securement device without exerting tension on the tube(s).
 - 8.1. Assess the site and notify Prescriber of any concerns of infection.
9. Remove gloves, perform hand hygiene and then apply sterile gloves.
 - 9.1. Don any additional personal protective equipment required as per point of care risk assessment.
10. Cleanse the area around the tube with Chlorhexidine 2% and Chlorhexidine 2% and 70% Alcohol (solution or swab) and allow to air dry completely.
Rationale: To prevent infection when tube is removed.

11. Identify the purse string vs. the stay suture that secures the chest tube (see figure 1.0).
NOTE: The purse string closing suture will be a different colour and increased length compared to the stay suture.
 - 11.1. Clip the stay suture closest to the patient and remove.
 - 11.2. Confirm that the tube is free from the sutures.
 - 11.3. **DO NOT** remove the purse string closing suture.**Rationale:** *The purse string closing suture will be used to close up the wound.*
12. One RHCP will remove the chest tube and the other will tie the purse string closing suture (See Appendix C: Tying a Purse String Closing Suture).
 - 12.1. The first throw of the knot “karate chop” is completed prior to removal of the chest tube.
13. Instruct the patient to take three deep breaths, hold the third one, and perform the Valsalva maneuver or alternatively take a deep breath and hum.
 - 13.1. Explain to the patient they will need to hold their breath or hum until the chest tube is removed and purse string is tied.
 - 13.2. If the patient is unable to obey commands or is on a ventilator, remove the chest tube(s) at the beginning of exhalation, just at the end of inspiration.**Rationale:** *Prevents a pneumothorax from air entering the pleural space as the chest tube is being removed. Having the patient hum gives audio confirmation that the patient is exhaling. Otherwise they could be taking a breath in silently.*
14. The first RHCP will remove the chest tube in a swift downward motion.
NOTE: If there is strong resistance with removing the tube stop the procedure, cover the site with an occlusive dressing and notify the Prescriber immediately.
Rationale: The tube may have inadvertently been sutured during surgery or is twisted.
15. Simultaneously while the chest tube is being removed, the second RHCP can gently tighten the purse string closing suture and complete a second “karate chop” knot and tighten.
Rationale: *Pulling the suture too tight will cause tissue necrosis at the site and make removal difficult later.*
16. The second RHCP will lock the suture using the “claw” technique.
17. Continue tying alternating knots 4-5 times (karate chop, claw, karate chop, and claw).
18. If the purse string suture is tied correctly, there is a proper seal and no fluid should leak and no air should get entrained. Therefore no dressing is required.
NOTE: If there is question whether the suture is tied correctly, the suture snaps, tied too loosely or fluid is leaking out an occlusive dressing will be applied.
Rationale: *An incorrectly tied purse string suture will default to an occlusive dressing to prevent any accidental air re-entry. An occlusive dressing on a chest tube site with a closing suture that is tied correctly may cause breakdown of the sutures.*
19. Assess the patient for any changes in respiratory status immediately post removal.
20. Assess the chest tube prior to discarding to ensure there was no fracture in the tube upon removal.
 - 20.1. Consult the Prescriber immediately if a portion of the tube remains in the patient.**Rationale:** *A piece of tube left inside the patient will require surgical removal.*

21. Discard supplies, remove PPE and perform hand hygiene.
22. Obtain chest x-ray if ordered.
23. When drainage system is discontinued from the patient ensure ports are sealed and disposed of in biohazard waste.

Rationale: *To ensure no leakage when discarded.*

Documentation

Document in the Interprofessional progress notes the following:

1. Date, time of removal
2. Patient and family education
3. Respiratory assessment before and after the procedure
4. Amount, colour, and consistency of drainage on the fluid balance record
5. Pain assessment and management
6. Type of suture in place and action taken (suture cut or tied)
7. Unexpected outcomes and related nursing interventions

9 COMPLICATIONS OF CHEST TUBE REMOVAL

Astute respiratory assessment is essential following chest tube removal, with each nursing assessment and as needed. Assessment includes observing the patient for signs/symptoms of respiratory distress, checking vital signs and auscultation of breath sounds. Patients must be observed for the following potential complications post removal.

Potential Complication	Location of Chest Tube	Cause	Signs/Symptoms	Nursing Interventions
Tension Pneumothorax	Pleural Space	Air rapidly accumulates in pleural space and cannot be evacuated. Pressure builds up, which collapses the lung and shifts the mediastinum, impeding venous return and cardiac output. It is life threatening and must be treated promptly	<ul style="list-style-type: none"> • Deviated trachea. • Acute chest pain in affected side. • Tachypnea. • Severe dyspnea. • Diminished chest wall expansion on affected side. • Hypotension • Jugular, venous distention. • Sudden sustained • Increase in airway resistance in a mechanically ventilated patient (high pressure alarm). 	<ul style="list-style-type: none"> • Notify Prescriber stat/activate a code 99. • Obtain a sterile 14-gauge angiocath (this should be inserted by the Prescriber as soon as possible to relieve tension and prevent hemodynamic collapse. • Note: The angiocath is usually left in place temporarily while a CT is inserted or removed, and an occlusive dressing applied over the site once the air is released. • Obtain chest tube insertion cart & supplies.
Retained Chest Tube	Mediastinal space or pleural space	Refers to when the tube fractures during drain removal and remnants of the tubing is left within the patient.	<ul style="list-style-type: none"> • Pain • Signs of infection (fever, redness at site, tenderness) • Dyspnea 	<ul style="list-style-type: none"> • Cover the site with an occlusive dressing. • Notify the service immediately.

Potential Complication	Location of Chest Tube	Cause	Signs/Symptoms	Nursing Interventions
Resistance on Removal	Mediastinum or pleural space	The tube may have been inadvertently sutured during surgery or sternal closure. It may also be kinked.	<ul style="list-style-type: none"> Resistance, difficult to remove. 	<ul style="list-style-type: none"> Stop the procedure and notify the Prescriber immediately.
Cardiac Tamponade	Mediastinum	Accumulation of blood in mediastinum (can be life threatening)	<ul style="list-style-type: none"> Decreased venous return. Decreased cardiac output. Jugular venous distention. Increased central venous pressure. Decreased blood pressure. Muffled heart sounds. Pulsus paradoxus (a rapid fall in blood pressure by 10 mmHg during inspiration). 	<ul style="list-style-type: none"> Notify Prescriber STAT. Arrange STAT portable X-ray and prepare for needle aspiration.
Recurrent Pneumothorax	Pleural space	a] Entry of air into the pleural space through the previous chest tube tract.	<ul style="list-style-type: none"> Decreased oxygen saturation levels. Increased work of breathing. Diminished breath sounds on affected side, increased restlessness. Chest discomfort. 	<ul style="list-style-type: none"> Re-apply or reinforce occlusive dressing if purse string sutures are not present. Ensure patient performs a Valsalva maneuver or remove the pleural chest tube at the beginning of exhalation. Notify physician. Arrange STAT port-able CXR. Check O2 sat.

Potential Complication	Location of Chest Tube	Cause	Signs/Symptoms	Nursing Interventions
		b] Undetected air leak prior to chest tube removal.	<ul style="list-style-type: none"> • Dyspnea. • Asymmetric chest movement. • Sudden, sharp chest pain. • Decreased or absent breath sounds on affected side. • Subcutaneous emphysema. 	<ul style="list-style-type: none"> • Elevate head of bed. • Obtain chest tube insertion cart/ supplies and prepare to re-insert chest tube. • Ensure there is no air leak prior to removal of the chest tube. • Reapply or reinforce occlusive dressing if purse strings are not present. • Notify physician. • Arrange STAT portable CXR. • Check O2 sat. • Elevate head of bed. • Obtain chest tube insertion cart supplies.
Persistent Bleeding	Mediastinum or pleural space	Chest tube may have been against a vein or an artery of the chest before removal. Patient may also have coagulopathy.	<ul style="list-style-type: none"> • Persistent bleeding 	<ul style="list-style-type: none"> • Monitor bleeding and hold pressure on the site.
Improper Tying of Purse String Closing Suture	Pleural	Purse string closing suture is inadvertently tied too loosely.	<ul style="list-style-type: none"> • Subcutaneous emphysema • Pneumothorax • Leakage of drainage from site 	<ul style="list-style-type: none"> • Cover the site with an occlusive dressing. • Notify Prescriber.

Table 1.0 Complications of Chest Tube Removal

10 PATIENT AND FAMILY EDUCATION

1. Explain the equipment and the procedure to the patient.
2. Explain to the patient will receive an analgesic before the procedure (if necessary, most often the pain quickly subsides after removal).
3. Describe the patient's role during tube removal. Explain that the patient will take three breaths, hold the third one, and perform the Valsalva maneuver. Instruct the patient to practice the maneuver before the procedure.
4. Instruct the patient to breathe deeply after the chest tube is removed. Instruct the patient to splint the affected side or sternum when coughing to decrease pain.
5. Instruct the patient to report signs and symptoms of respiratory distress or infection immediately.
6. Encourage questions and answer them as they arise.

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12 Authorization Test: Removal of a Chest Tube (Pleural or Mediastinal)

Please indicate your answers by circling the appropriate letters on the test answer sheet following the test questions.

1. Which statement best describes the physical relationship between both lungs and mediastinum?
 - a. all three compartments are connected via direct air communications
 - b. all three compartments are physically separate from each other
 - c. the lungs are connected via communicating pleural spaces but the mediastinum is independent
 - d. the mediastinum and right lung are connected via pleural membranes but the left lung is independent

2. Normal intrapleural pressures are in a range listed below. Select the correct range for pleural pressures.
 - a. +3 to +10
 - b. 0 to +4
 - c. -5 to +5
 - d. -5 to -8

3. Which of the following features of pleural drainage systems indicate an active pleural leak?
 - a. bubbling in the water seal chamber
 - b. bubbling in the collection chamber
 - c. fluctuation of water in the water seal chamber with respirations
 - d. no fluctuation of water in the water seal chamber with respirations

4. Anterior chest tubes for the drainage of air causing a pneumothorax is usually placed in which intercostal space (ICS)?
 - a. first ICS, anterior clavicular line
 - b. second ICS, mid-clavicular line
 - c. fourth ICS, anterior axillary line
 - d. sixth ICS, mid-axillary line

5. While removing Mr. Smith's chest tube with a purse string closing suture you complete your last knot and note drainage leaking from the incision. What do you do?
 - a. continue and leave the incision open to air
 - b. apply a occlusive dressing
 - c. apply a dry dressing
 - d. none of the above

6. Chest tubes for the drainage of fluid from the pleural space are usually placed in which intercostal space (ICS)?
- second ICS, mid-clavicular line
 - fourth ICS, mid-clavicular line
 - fifth ICS, anterior axillary line
 - seventh ICS, posterior axillary line
7. A 23 year old female admitted 3 days ago following a motor vehicle accident, has a fourth and fifth rib fracture on the left. You have just removed her left pleural chest tube that she has had for 3 days. Shortly after removal of the chest tube, she develops marked shortness of breath, has a rightward deviation of her trachea, and diminished breath sounds on the left. What condition is likely developing?
- closed pneumothorax
 - tension pneumothorax
 - flail chest
 - cardiac tamponade
8. Mr. Brown was transferred to your unit yesterday following his right middle lobe wedge resection. His anterior and posterior pleural tubes have remained connected to a double chamber Pleur-evac® overnight. His anterior chest tube has drained 100mL overnight and his posterior chest tube 200mL overnight. The physician has ordered his anterior chest tube to be removed. Prior to removal of his anterior chest tube, you should:
- clamp the anterior chest tube
 - turn off the suction
 - clamp the posterior chest tube
 - assess patient need for analgesia
 - instruct the patient on holding breath during removal

The correct interventions are

- I, II, III
- II, III, V
- I, III
- II, IV, V

9. A 42 year old female was admitted to the intensive care unit following a stabbing incident 2 days ago. On admission she was extremely agitated and required sedation to insert a right pleural chest tube. She has been weaned this morning and now is extubated. There is an order to remove her chest tube. Currently she is **confused** and **uncooperative**. Her chest tube is removed
- at the beginning of inspiration
 - at the end of exhalation
 - at the beginning of exhalation
 - none of the above
10. A 73 year old male who had aortic valve replacement surgery has a physician's order to have his mediastinal chest tubes removed this morning. You turn the chest tube suction off and prepare the patient/ equipment according to procedure. As you attempt to remove the two adjacent tubes together, you meet with resistance removing one (1) or the tubes. You should:
- stop the procedure and re-dress the insertion site with an occlusive dressing
 - stop the procedure and administer more analgesic to the patient prior to continuing
 - notify the physician
 - remove the chest tube with no resistance and leave the second tube in place
- I and III
 - II and IV
 - IV only
 - III only
11. Following removal of a chest tube, document in the Interprofessional Progress Notes:
- date and time of removal
 - condition of site
 - patient's tolerance of the procedure
 - all of the above
12. A Prescriber orders an anterior chest tube out. The patient also has a posterior chest tube in place. Prior to pulling the anterior tube, you note that that it has an air leak. You would:
- clarify order
 - pull the anterior tube
 - not pull the anterior tube

13 Pleural or Mediastinal Chest Tube Removal: Test Answer Sheet

Name: _____ Date: _____

1. a b c d

2. a b c d

3. a b c d

4. a b c d

5. a b c d

6. a b c d

7. a b c

8. a b c d

9. a b c d

10. a b c d

11. a b c d

12. a b c d

Appendix A: Removal of a Chest Tube Performance Checklist

Name: _____ Date: _____

Assessor: _____ Unit: _____

The RHCP will remove a chest tube consistent with the Performance Checklist (based on the procedure) and will correctly answer questions about the principles underlying the skill.

NURSING ACTION(S)	YES	NO	COMMENTS
1. Positions the patient to expose the chest tube(s).			
2. Turns chest tube suction off, if applicable.			
3. Removes the chest tube dressing without exerting tension on the tubes.			
4. Prepares the occlusive dressing.			
5. Applies appropriate PPE, cleanses chest tube insertion site(s).			
6. While holding the chest tube, cuts and removes the securing suture.			
7. Instructs the patient to take a deep breath, hold it and bear down (Valsalva maneuver) or hum. Alternatively if uncooperative removes at the end of inspiration and beginning of exhalation)			
8. Loosely applies occlusive dressing over chest tube insertion site(s) with one hand.			
9. With the other hand, removes the chest tube(s) in a swift downward motion while the patient is holding his/her breath or humming.			
10. Secures occlusive dressing over site.			
11. Assesses the patient for any changes in respiratory status.			
12. Documents in progress notes: <ul style="list-style-type: none"> • date and time of removal; • condition of site; and • patient's tolerance to the procedure. 			
13. Documents amount of drainage on the Fluid Balance Record.			

Appendix B: Tying a Purse String Closing Suture Performance Checklist

Name: _____

Date: _____

Assessor: _____

Unit: _____

Note: Additional authorization. Requires two RHCP one to pull the chest tube and the other to tie the purse string closing suture. The nurse will tie the purse string closing suture consistent with the defined organizational knowledge and skill evaluation.

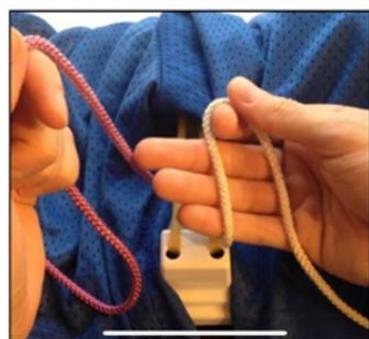
NURSING ACTION(S)	YES	NO	COMMENTS
1. Positions the patient to expose purse string suture.			
2. Before the procedure, begin first "Karate Chop" knot so it is ready when the Chest Tube is pulled.			
3. Instructs the patient to take a deep breath, hold it and bear down (Valsalva maneuver) or hum. Alternatively if uncooperative removes at the end of inspiration and beginning of exhalation.			
4. Once the Chest Tube is pulled, the other RHCP (patient is still performing Valsalva maneuver), ties the knot tight. Quickly follow with another "Karate Chop" and then lock the suture with "The Claw".			
5. Continued tying alternating knots 4-5 times.			
6. Assess the site for any drainage and the patient for any changes in respiratory status. <i>Question: What would you do if you tied the knot incorrectly and fluid was leaking from the site?</i>			
7. Documents in progress notes: <ul style="list-style-type: none"> • Use of purse string closing suture • Appropriate site closure and left open to air. • Any concerns and appropriate steps taken i.e. leaking and occlusive dressing applied. 			

Appendix C: How to Tie a Purse String Closing Suture

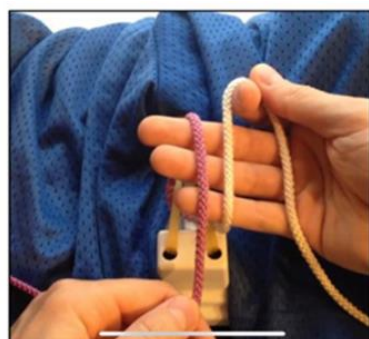
“Karate Chop Knot”



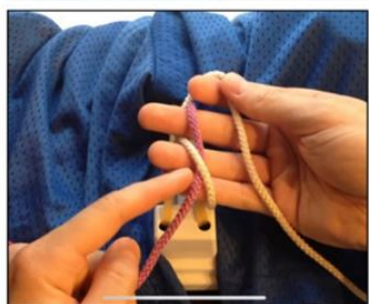
Step 1: Non-dominant hand holds the “post” string. Majority of the work is done with your dominant hand. Drape the suture across your dominant hand.



Step 2: Pinch the string between your pointer finger and your thumb. Open your hand up and “karate chop” the string.



Step 3: Post string you are going to drape over in the opposite direction.

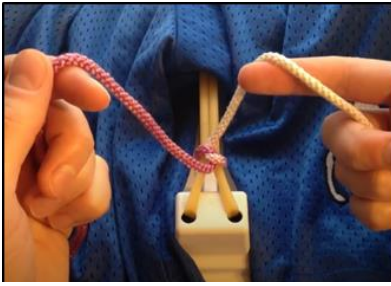


Step 4: With your middle finger you are going to go over the post string and under the dominant.



Step 5: Pinch the dominant side string between your middle finger and your ring finger and pull it through the loop you created. Pull it tight. This will create your first knot.

“Claw Locking Knot”



Step One: Start the same way, secure the string with your bottom three fingers and extend your pointer finger.



Step Two: You can help position this with your thumb and it will look like a “claw”.



Step Three: Take the post and wrap it around your finger in the opposite direction.



Step Four: Using your pointer finger go over the post and under the dominant and rotate it through with your pointer finger.



Step Five: Pull the free end through the loop and tighten. This will lock your knot.