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Title: Rare Malposition of a Central Venous Catheter into the Left Internal Mammary Vein in a Liver Transplantation Patient

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Abstract: We report a rare malposition of central venous catheter in a liver transplantation patient occurred during intensive care period. The waveform of central venous pressure was aberrant after connecting the catheter to the pressure kit transducer. It was misplaced into left internal mammary vein confirmed by thoracic Computed Tomography. Significant engorgement of left internal mammary vein may have been the cause of this rare malposition.

Response to Reviewers: Dear reviewers and Editor-in-Chief:

Thank you for reviewing our manuscript and providing us again such great comments. We also sincerely appreciate you to be interested in publishing our work in Journal of Anesthesia. We have revised the text as your recommendations in the following description. Thank you so much!

Minor comments

>Page 4, Line 17

This sentence "Portal hypertension induced collateral vessels were predominantly symmetrical." Has been revised to "Although the left IMV was cannulated by the CVC and hard to measure the exact diameter but portal hypertension induced collateral vessels were almost symmetrical."

>9Fr Trauma catheter

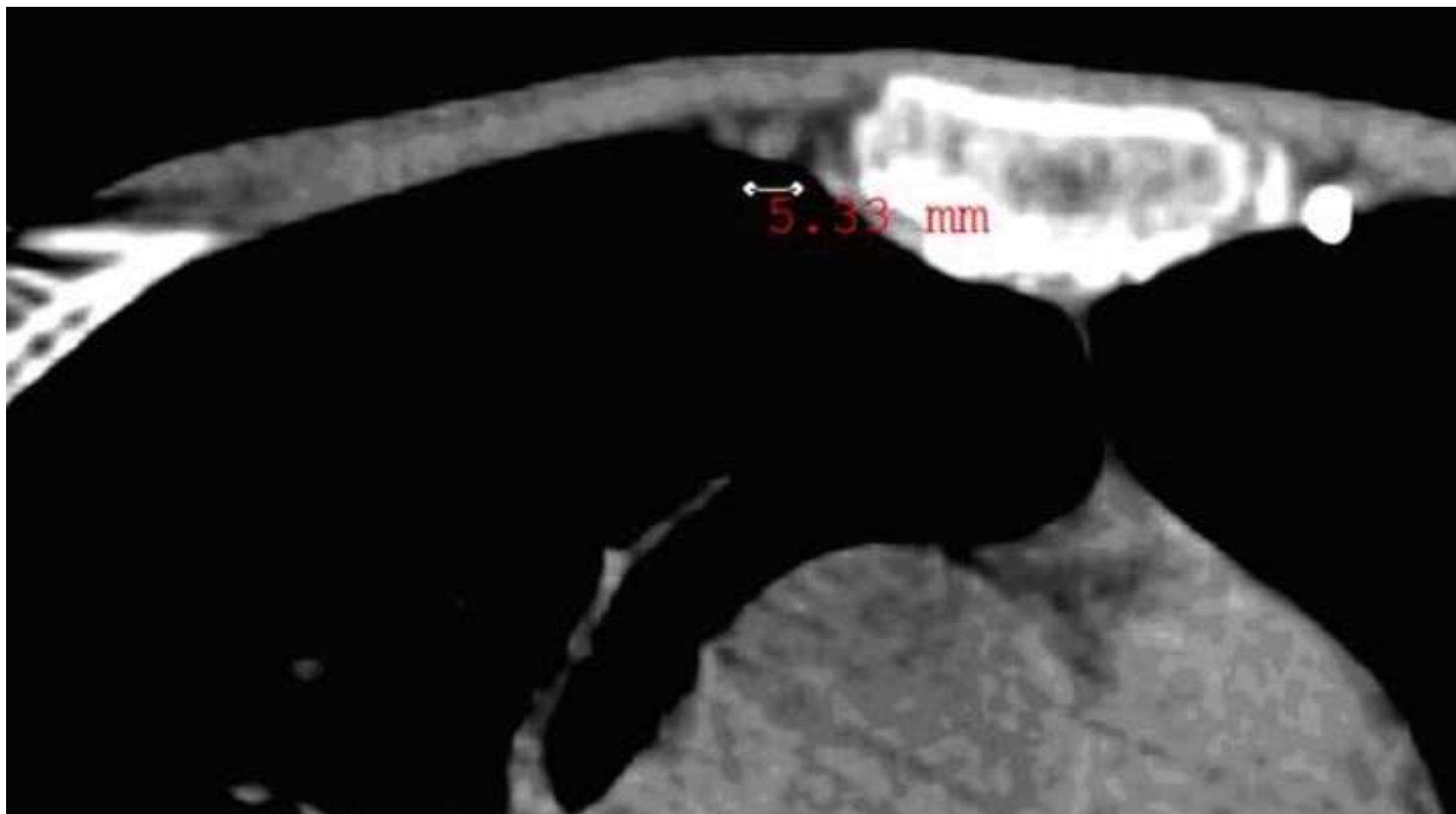
The name and the manufacturer of the catheter have been added in the text.

A 9 Fr. trauma catheter (Multi-Med Central Venous Catheter, triple lumen, Edwards Lifescience) was in the right IJV in this patient, which had been cannulated after general anesthesia for massive transfusion during operation.

Figure 3
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Figure 4
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Rare Malposition of a Central Venous Catheter into the Left Internal Mammary Vein in a Liver Transplantation Patient

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Keywords: Central venous catheter, malposition, liver transplantation, portal hypertension,
internal mammary vein

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Abstract

We report a rare malposition of central venous catheter in a liver transplantation patient occurred during intensive care period. The waveform of central venous pressure was aberrant after connecting the catheter to the pressure kit transducer. It was misplaced into left internal mammary vein confirmed by thoracic Computed Tomography. Significant engorgement of left internal mammary vein may have been the cause of this rare malposition.

1 A central venous catheter (CVC) provides measurement of hemodynamic variations and
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4 allows delivery of medications and nutritional support. Various complications of central
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7 venous catheterization have been reported including: malposition, arterial puncture,
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10 hematoma, pneumothorax, hemothorax, infection and thrombosis. In this report, a CVC was
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13 placed via the left internal jugular vein (IJV) in a patient following a liver transplantation.
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16 Malposition of the CVC into the left internal mammary vein (IMV) was subsequently
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19 diagnosed. The main cause of this rare malposition and the methods of prevention are
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22 discussed in the following.
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26 A 54-year-old man was admitted to surgical intensive care unit following a liver
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29 transplantation for end-stage liver cirrhosis. After local anesthesia the left IJV was punctured
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32 and dark venous blood was obvious. No difficulties were encountered inserting the J-tip
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35 guide wire and the dilator. An 8 Fr. three-lumen CVC was subsequently railroaded and
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38 advanced 20 cm without encountering any resistance and venous blood aspirated through the
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41 three lumens of the catheter without any signs of obstruction. The patient experienced no
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44 hemodynamic changes through the procedure. The waveform of central venous pressure
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47 (CVP) was aberrant after connecting the catheter to pressure kit transducer. Instead of typical
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50 a,c,v waves and x,y descents, a flattened CVP waveform presented. A roentgenogram was
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53 immediately arranged to confirm the catheter position (**Figure 1**). The catheter descended
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56 lateral to the left mediastinal margin without signs of either a pneumothorax or pleural
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1 effusion. A thoracic Computed Tomography (CT) scan was then performed to better define
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4 the exact anatomic location of the CVC (**Figure 2**). CT revealed that the CVC was inserted
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7 into the left IMV.
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10 A CVC is useful for critical patients in the intensive care unit for hemodynamic monitoring,
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12 fluid resuscitation, intravenous drug infusion and hyperalimentation. Malposition of the CVC
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14 is only rarely reported with an incidence of 1% to 6% [1]. Despite its rarity, CVC
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16 malpositioning can lead to disastrous results. Congenital anomalies in the patient's anatomy,
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18 postoperative anatomic changes or disease-induced structural alterations each can increase
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20 the incidence of CVC malpositioning. The left IMV is one of the tributaries of the left
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22 innominate vein. Generally, the left IMV is a small tributary and is not easily tunneled by a
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24 J-tip guide wire in spite of the fact that the IMV's opening is almost opposite to the orifice of
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26 the IJV. The IMV plays an important role in collateral circulation during portal hypertension
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28 and is thought to be more engaged in portohypertensive patients [2]. The patient described
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30 herein had long-term liver cirrhosis (Child-Pugh class C). During liver transplantation,
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32 significant engorgement of the venous system was noted by the surgeon. Furthermore, the
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34 thoracic CT after CVC catheterization showed that the patient's right IMV was 5.33mm in
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36 diameter which was almost twice dilated than a normal one. **Although the left IMV was**
37
38 **cannulated by the CVC and hard to measure the exact diameter but portal hypertension**
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40 **induced collateral vessels were almost symmetrical.** This evidence convinced us that the
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1 guide wire could descend straight into the left IMV without resistance and make a CVC
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3 tunneling easier. This unexpected catheterization of left IMV has previously been reported in
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5 the literature; however, the patient reported herein appears to be the first case in whom
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7 malposition of the CVC into a presumably dilated left IMV following liver transplantation
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13 [3].
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16 Webb et al. reported a localized pain in such type of malposition and Kanter and Connelly
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18 described retrosternal chest pain radiating to the back as the most common symptom of
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20 malposition [4,5]. The report by Sandroni et al., however, stated that their patient had no
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22 specific symptoms with left IMV tunneling [3]. Subjective discomfort was not obvious as has
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24 been reported by others because the patient presented in this report was intubated during
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26 catheterization. In the case described here, the error in tunneling could not be detected until
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28 an aberrant CVP waveform was noted. Sandroni et al. stated their patient had the CVP value
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30 of 7 cmH₂O without mention of the waveform[3]. For detecting locations of CVC, the CVP
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32 waveform is more important than the value because actual central venous tracing indicates
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34 the appropriate location of the CVC tip.
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47 This case highlights the importance of CVP waveform monitoring and chest
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49 roentgenogram to ensure proper catheter placement, especially in unconscious or intubated
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51 patients in the intensive care unit. Fluoroscopic examination and CT scanning are also useful
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55 tools in cases of CVC malpositioning for identification of the cannulated vein [3].
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1 A 9 Fr. trauma catheter (Multi-Med Central Venous Catheter, triple lumen, Edwards
2 Lifesciences) was in the right IJV in this patient, which had been cannulated after general
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4 anesthesia for massive transfusion during operation. That is why the left IJV was selected for
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7 insertion of the CVC before removing the 9 Fr. trauma catheter. Whenever possible, CVC
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10 should be placed via the right central vein because the left IJV has more tributaries than the
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13 right when it converges into the left innominate vein [2]. If catheterization on the left side is
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16 necessary, approaching from the left subclavian vein can attenuate the risk of small tributary
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19 tunneling. In addition, limiting the depth of insertion of the guide wire during left IJV
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22 cannulation will also decrease the chances of IMV tunneling [2].
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29 In summary, chances of CVC malpositioning to the left tributaries via left IJV
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31 catheterization is increased in patients with portal hypertension. Right IJV cannulation
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34 decreases the incidence of malpositioning, which can be symptomatic or asymptomatic. CVC
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37 waveform monitoring and radiological verification for accurate CVC positioning is essential.
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7 **Figure Legends**
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10
11 Figure 1 Chest roentgenogram shows the 8 Fr. CVC (white arrows) descending lateral to
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13 the left mediastinal margin. The black arrows indicate the 9 Fr. trauma catheter (a)
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15 and tracheal tube (b).
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19
20 Figure 2 The thoracic CT scan with 3D reconstruction shows the catheter (arrows) behind
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22 the sternum in the left internal mammary vein.
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Figure1
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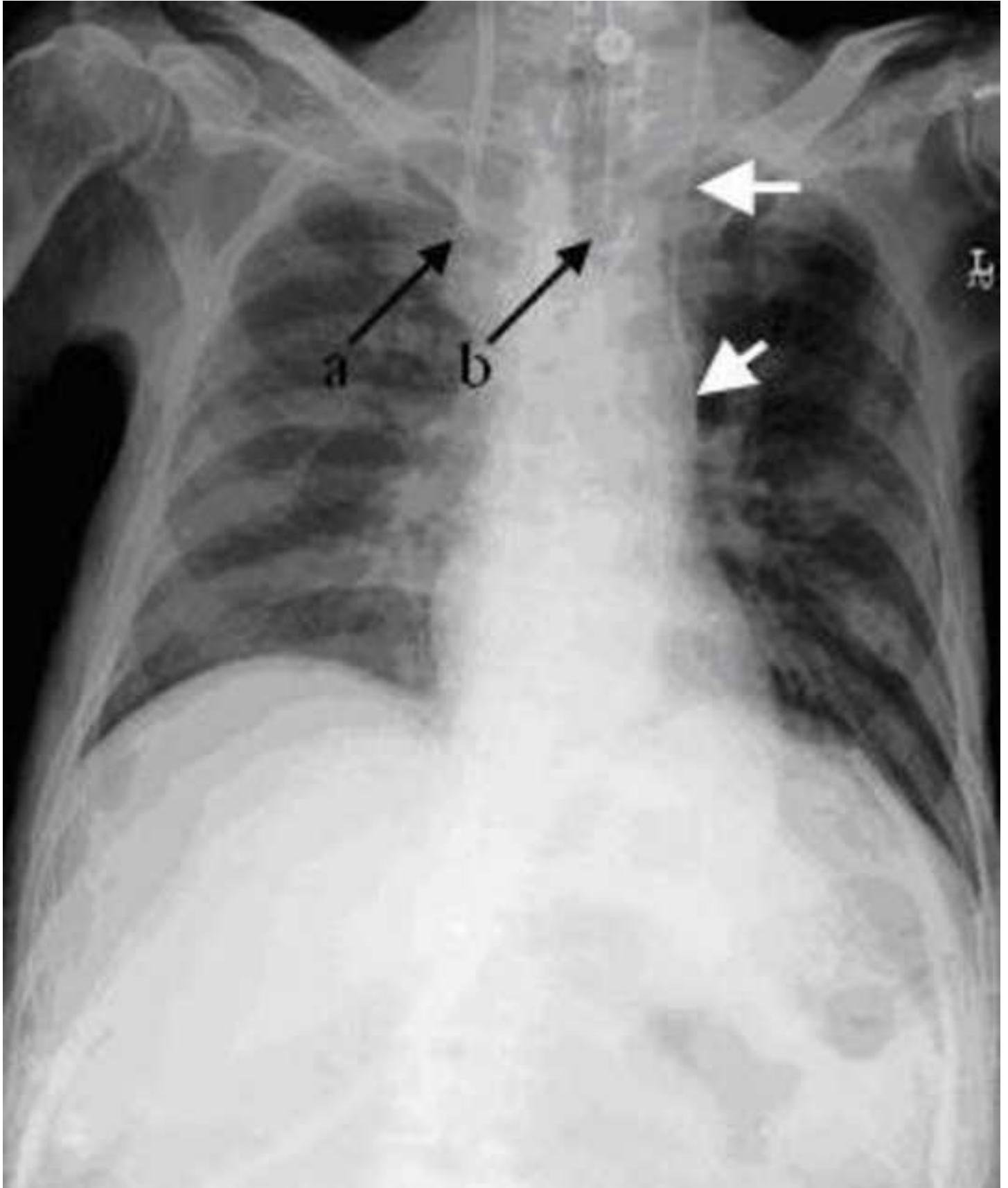
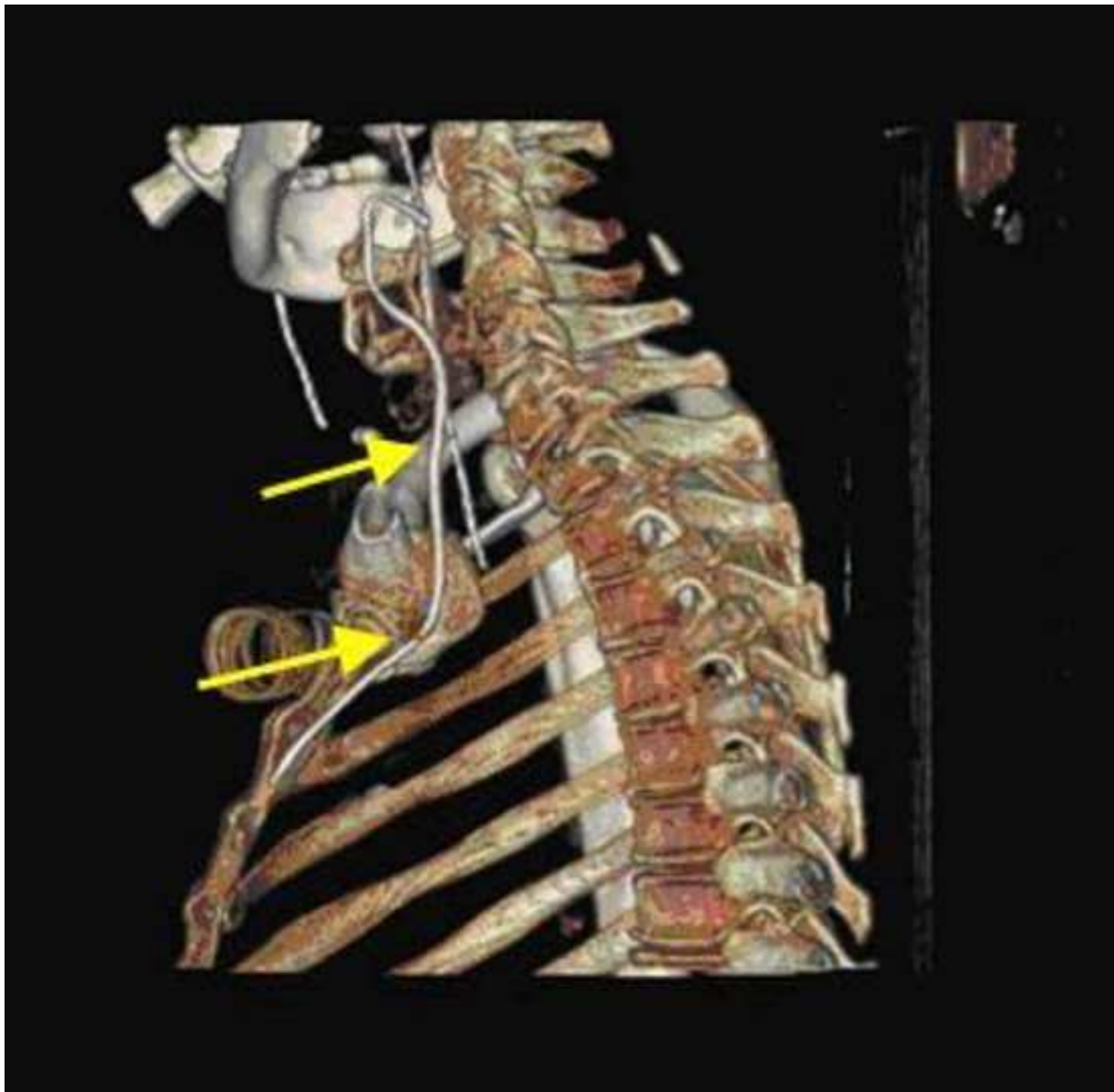


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