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Ultrasound guided percutaneous dilatation tracheotomy (US-PDT) to prevent potentially life-threatening complications: A case report

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ABSTRACT

INTRODUCTION: Percutaneous dilatation tracheotomy (PDT) is a relatively recent technique that enables non surgeons to perform tracheotomies at bedside reducing operation rooms schedules. It is burdened by a moderate risk of postoperative bleeding.
PRESENTATION OF CASE: The patient was a 57 years old with a temporal intraparenchymal hematoma, submitted to percutaneous dilatation tracheotomy. Despite the favorable anatomical features, a pre-procedural US was performed, identifying a pulsating vessel with an arterial pattern, 2 cm above the hollow. The procedure was then considered at high risk, an operation room was required for the technique and an on-call surgeon was alerted.

The procedure was ended safely and any bleeding was avoided because the technique was practiced with the best precautions.
DISCUSSION: PDT strength is the possibility for non surgeons to perform tracheotomies in selected patients at bedside, reducing operation rooms congestion. Such technique though is a "blind" technique, and post-operative bleedings can occur and represent a feared complication. Conversely, the surgical tracheotomy permits a better control of hemorrhages, but needs the involvement of a surgeon and availability of an operation room. Performing a PDT guided by a neck ultrasound is useful to identify eventual aberrant vessel whose course could complicate the tracheotomy, it is part of PDT guidelines of some States.
CONCLUSION: US-PDT could help reducing procedure related complications selecting those high risk patients still in need of operating room and surgical assistance. US-PDT feasibility combined to its easy availability and low costs encourage its introduction into everyday practice.

1. Background

Tracheotomy is a standard procedure for airway access in critical patients undergoing mechanical ventilation or requiring airway protection for prolonged periods. Percutaneous dilatation tracheotomy (PDT) is a relatively recent and easy technique [1] enabling non-surgeons to perform the procedure at patient's bedside in intensive care units, whereas the standard surgical open tracheotomy (SOT) requires operation rooms and trained surgeons. Whenever possible, PDT currently represents the procedure of choice, it saves transport costs and logistics, and does not impact operating room schedule, saving hospital resources [2]. Short- and long-term complications have been described, among which bleeding is the most dreaded [3]. Neck ultrasound guided PDT (US-PDT), eases blood vessel identification resulting in a more safe technique. It can also be used to identify those high risk patients who are better eligible for surgical technique (ST) for specific anatomical reasons.

We report the case of successful and proper use of US-PDT, which identified an otherwise undetectable vascular anomaly, allowed the identification of the ideal site of tracheotomy, preventing a massive hemorrhage. The work has been reported in line with the SCARE and PROCESS criteria [4,5].

2. Case presentation

The patient was a 57-year-old woman with a temporal intraparenchymal hematoma. A skilled operator performed a PDT under

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Fig. 1. Lower thyroid artery course displayed at CT scan.

optical-fibre guidance. The neck was thin, no visible abnormalities were registered, and the trachea was easily palpable. Despite the favorable anatomical features, a preprocedural US was performed, as it is routinely performed at our center. The patient was positioned with her head bent off and supported; additionally, a small rolled-up towel was placed at the level of scapulas to provide hyperextension. The US examination showed the presence of a pulsating vessel 2 cm above the hollow, half way between the thyroid cartilage and the suprasternal notch. A combination of B-mode and Color Doppler ultrasound permitted to characterize such vessel by an arterial pattern. Therefore, the PDT technique was considered at high risk, as the whole pre-tracheal median area did not show ideal site for needle placement. The vessel was located between the second and third tracheal ring in the median area, modifying the intended tracheotomy site. In order to avoid the identified vessel and a possible major complication, an angio-CT scan was performed and permitted the precise definition of the artery as a branch of the lower thyroid artery. The course of the artery is shown in Figs. 1 and 2. The abnormal course of the vessel in this specific case determined inability of securely performing the procedure at bedside, as the chance of hemorrhage was concrete, and the possible intervention of a surgeon was enforced. Tracheotomy was performed in the operation room and a first attempt of using the percutaneous technique was carried out. A surgeon was alerted and participated to the procedure. The position of the needle was tailored on the specific patient and modified according to the US a TC scan founding. The introducer needle was safely inserted, during suctioning, into the trachea using a fiberoptic bronchoscope and its correct location within the trachea confirmed by aspiration of air. The guidewire was passed through the needle with no evidence of bleeding. The operator could then wide the puncture channel with a punch dilator, bypassing the abovementioned arterial structure. The oro-tracheal tube was safely put in place using Seldinger technique according to the Ciaglia Blue Rhino approach [6]. A very likely conversion to SOT was contemplated but avoided with the precise preprocedural anatomical study. US-PDT permitted take the appropriate precautions as the need of an operation room and the possible involvement of a surgeon. The procedure ended with a second US examination checking for the right positioning and functioning of the tracheotomy.

3. Discussion

PDT is a relatively recent tracheotomy technique nowadays gaining growing consensus on selected patients, compared to the traditional SOT. Beside PDT indication is still limited to stable patients, not requiring emergency airway access, non oncological and without any evident anatomical aberration [7], its strength compared to the SOT is the possibility to be performed by trained intensivists rather than surgeons and at bedside [2], resulting in a reduction of costs and rescheduling programs. Concerns also remain about the real US-PDT complication rate and the presumed superiority than SOT. It is in noteworthy that surgical tracheotomy permits a better management of eventual intraoperative complications as hemorrhage [8–9]. A critical PDT complication as for being a “blind” even if “blunt” tracheotomy technique, is, in fact, the hemorrhage rate, either occurring during or after the procedure. Regardless the actual blood loss quantity, tracheal hemorrhage can in fact be life-threatening. Visibility with flexible bronchoscopy in the surgical field is highly compromised even for small amounts of blood, and since airways are dead space, intratracheal hemorrhage though be ingnegligible, can result in severe acute hypoxia, even long before circulation is affected [10]. While external bleeding might require primary revision surgery only possible in SOT, internal bleeding should immediately managed to secure airway and monitor gas exchange. According to Simon et al., PDT-related death is reported in 1 out of 600, 35% of which occur during the procedure due to a PDT related hemorrhage [11], for unrecognized vascular variations. Several studies have been conducted to

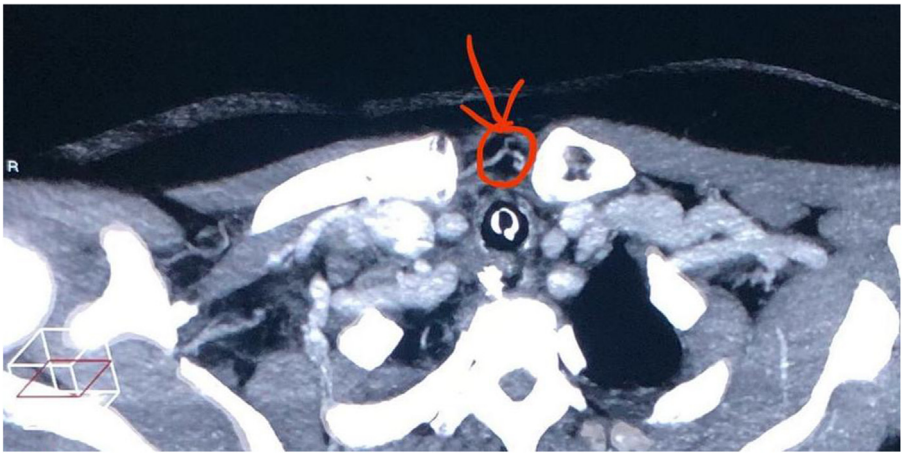

Fig. 2. Lower thyroid artery course displayed at CT scan.

precisely set the risk of mortality rate for perioperative bleeding associated to PDF, but the values still range from 0.39% to 5% [12,13]. Moreover, postoperative bleeding seems to occur in 2.2% of PDT, according to many Authors [14]. PDT can be dangerous because of the vascular anatomy of the pre tracheal area, from the cricoid cartilage to the suprasternal notch, as the needle and the tube are placed blindly. The hemorrhage risk is not reduced by the common associated performance of a bronchoscopy, allowing the real-time confirmation of needle placement in the midline position. Conversely, US-PDT has caused to change the intended tracheotomy site in approximately 24% of cases, and up to 50% of cases in other studies [15]. The lack of Literature data on the use of US-PDT requires further large studies, though it has recently been included in the Australian and New Zealand Intensive Care Society practice guidelines [16]. According to severalauthors in fact, its role in "landmarking" is confirmed. Locating crico-thyroid membrane and setting a site for tracheal puncture when the tracheal anatomy is not readily palpable can be eased by US-PDT, as well as it includes information about the anatomy of the pre- and paratracheal region [17]. Given US capacityto determine the distance from skin to the trachea, an additional role of US-PDT might also be of choosing an appropriate tracheotomy size, allowing the selection of selection of the oro-tracheal tube size. US neck examination is known to allow the identification of vulnerable structures, such as blood vessels and the thyroid gland, in the neck prior to PDT. In our paper, US-PDT maximized the alert on this particular case, deepening the anatomical study of the aberrant vessel. It enabled to perform the procedure under the best circumstances: the presence of a surgeon was required, and an operating room was available. Moreover, US might be performed during the procedure as well, as playing a major role in revealing potentially aberrant vessels, allowing the operator to guide needles and dilators away from at-risk structures, thus avoiding immediate complications as periprocedural hemorrhage [18–19]. The decisive role of US in choosing and adequate puncture location is established, both in individuating the right inter-tracheal space and the midline. US-PDT has also demonstrated to significantly reduce the procedural time when compared to PDT without US examination or SOT, as reported by Sustic et al. [20]. However, intraluminal air strongly limits visualization of structures; thus, US-PTD does not seem to avoid injuries of the posterior tracheal wall. Therefore, a safe PDT procedure should in fact adjunct both US and bronchoscopy to the protocol. Further studies are needed to compare bronchoscope-guided PDT alone with US-PDT.

4. Conclusions

PDT is an established procedure in critical patients in need of tracheotomy. US combined with fibroschopy to guide PDT in all of its phases, helps tracing anatomical aberrations not detectable with palpation, determining anatomical landmarks and finding the right site for tracheotomy, especially in short necks and obese patients. Moreover, US -PDT could help reducing procedure related complications selecting those high risk patients still in need of operating room and surgical assistance. US-PDT feasibility combined to its easy availability and low costs encourage its introduction into everyday practice. Further prospective studies are needed to assess the safety and efficacy of US-PDT compared with the traditional landmark-guided technique.

Data statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Ethical approval

N/A.

Consent

A written informed consent was obtained form the patients by the Authors.

Author contribution

GG: Participated substantially in conception, design and execution of the study, and in the drafting and editing of the manuscript.
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