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REPLY, LETTER TO THE EDITOR

# Strategy to Prevent Subcutaneous Emphysema and Gas Insufflation-Related Complications in Transoral Endoscopic Thyroidectomy Vestibular Approach: Reply

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Dear Editor,

Various approaches to endoscopic and robotic thyroidectomy have been developed over the last two decades in order to reduce or avoid the formation of scarring on the anterior neck, which is a concern for patients, especially Asians. Generally, carbon dioxide ($CO_2$) is used as gas insufflation in most laparoscopic procedures, including endoscopic and robotic thyroidectomy. With the benefit of inertia, non-inflammable, absorbable in circulation and then excreted by exhalation, $CO_2$ is ideal for laparoscopic gas insufflation [1]. In laparoscopic abdominal surgery, the gas is insufflated into the abdominal cavity and rarely causes any major problems. However, endoscopic thyroidectomy is performed by creating an unnatural working space between the muscles and subcutaneous fat of the neck area. As a result, subcutaneous emphysema may develop with inappropriate settings [2–4].

Subcutaneous emphysema has been defined as having air tapping in the subcutaneous fat and can be palpated as the crepitus over the skin. This condition can also be found in pneumothorax patients. However, subcutaneous emphysema found after endoscopic thyroidectomy is different because this condition is caused by direct $CO_2$ insufflation. Thus, the only management for this condition is conservative treatment. Close observation and oxygen supply should be given. The $CO_2$ will eventually be absorbed and excreted from the body through exhalation within 24–48 h, without complications. For this reason, most endoscopic and robotic thyroidectomy techniques typically employ $CO_2$ for gas insufflation [5, 6].

Since thyroid natural orifice transluminal endoscopic surgery (NOTES) has increased in popularity, we developed and have continued to refine the transoral endoscopic thyroidectomy vestibular approach (TOETVA) since 2014 [7]. Our continued work has been reported with no gas-related complications [8, 9]. The only problem with the transoral thyroidectomy procedure was reported by Wilhelm et al. in their series using a sublingual approach [10]. One case (12%) of mediastinal emphysema was found and treated by conservative management. No other major complication was observed.

In a series of TOETVA by a Taiwanese surgeon, 38.8% were found to have subcutaneous emphysema that required staying in the PACU >2 h. This was because some patients developed stridor or difficulties in breathing. However, no major complications related to insufflation were found. In that report, 6 mmHg pressure was insufflated [11]. However, gas flow setting was not reported. This is noteworthy because the setting of pressure and gas flow is critical in preventing insufflation-related issues. In our series, more than 600 patients received TOETVA, with only 10 cases developing simple subcutaneous emphysema by palpating of the crepitus at the anterior chest well. No other respiratory symptoms were observed. No mediastinal emphysema, pneumothorax, or $CO_2$ embolism occurred. Thus, only conservative management was needed.

In our hospital, the following points of strategy for TOETVA are now used for the prevention of problems: (1) There were experimental reports in pigs showing that the upper limit for $CO_2$ pressure should not exceed 10 mmHg in endoscopic thyroidectomy [2, 12]. Another human series confirmed that <9 mmHg was considered

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safe for robotic thyroidectomy [3]. However, optimum pressure is required in order to cause minimal complications but still provide good visualization. In our institute, $CO_2$ pressure should not exceed 6 mmHg and a flow rate of 15 L/min should be set. In some circumstances where a wider working space is needed, such as for a big goiter, the flow rate can be temporary increased to 20 L/min. After that, the flow rate should be returned to the optimal setting. (2) Intermittent release of the gas from the working space through the valve of 5 mm ports is required. This strategy is essential, especially for the time when an energy device is activated to release smoke. This also helps to release the pressure and tension inside the flap. Care must be taken not to close the valve all the time because there will be some absorption of $CO_2$ into the subcutaneous fat. (3) End tidal $CO_2$ ($etCO_2$) should be monitored for the entire operation. Thus, communication between the surgeon and anesthesiologist is imperative. If $etCO_2$ exceeds 45, the gas flow must be reduced to 10 L/min, which is sufficient to raise the flap with fair visualization and allow the operation to be continued. After $etCO_2$ is less than 35, the gas flow can be returned to 15 L/min. (4) Right after the operation is finished, we always access the subcutaneous emphysema in the operating room. After extubation, respiration as well as oxygen saturation is observed in the recovery room. If subcutaneous emphysema occurs, closer observation and a mask with bag oxygenation shall be provided. If the patients have no other symptoms, they can be discharged to a normal ward.

Utilizing this strategy, we have had very few gas insufflation-related problems in our series. We are confident that this strategy should not only be for TOETVA, but should be used for all endoscopic and robotic thyroidectomy operations. In the future, we encourage surgeons and anesthesiologists to continue investigating this problem with prospective study to confirm both the safety of this strategy and that subcutaneous emphysema resulting from $CO_2$ insufflation in laparoendoscopic procedures is only a minor complication and a self-limited condition treatable with conservative management.

**Compliance with ethical standards**

**Conflict of interest** The authors declare that they have no conflict of interest.

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