Dr. Naveed Siddiqui: Thank you, Dr. Sweitzer. It’s an honor to be here with you on this platform.

Dr. BobbieJean Sweitzer: So, maybe we should start out with you just giving us a little bit of a background or understanding as to what you intended to do with this study. What kind of questions were you aiming to answer?

Dr. Naveed Siddiqui: Thank you. I’m Naveed Siddiqui, Professor of Anesthesiology at Northwestern University and an Associate Editor for Anesthesiology and you are listening to an Anesthesiology podcast designed for physicians and scientists interested in the research that appears in our journal.

Today we are speaking with the author of a publication that appears in the December 2018 issue of the journal. With us is Dr. Naveed Siddiqui. Dr. Siddiqui is the senior author of an article titled “Ultrasound Is Superior to Palpation in Identifying the Cricothyroid Membrane in Subjects with Poorly Defined Neck Landmarks: A Randomized Clinical Trial.” He is an Associate Professor in the Department of Anesthesia and Acute Pain Service at Mount Sinai Hospital and the University of Toronto in Toronto, Ontario, Canada. Welcome, Dr. Siddiqui.

Host: Welcome to the Anesthesiology journal podcast, an audio interview of study authors and editorialists.

Dr. BobbieJean Sweitzer: Hello. I’m BobbieJean Sweitzer, Professor of Pain Service at Mount Sinai Hospital and the University of Toronto in Toronto, Ontario, Canada. Welcome, Dr. Siddiqui.

Dr. Naveed Siddiqui: Good. So, that sets the stage for, I think, what I want to talk about and, you know, that’s the role of ultrasound in the airway. So, okay. Good. So, that sets the stage for, I guess, that we would expect that more difficult patients, or with a difficult anatomy, may be both more difficult, I guess, for a palpation as well as potentially more difficult for ultrasound. So, I guess you’re going to tell us a little bit more about that.

But before we get to that question, what were the typical neck pathologies that these patients had in your study population?

Dr. Naveed Siddiqui: So, we had a cohort of patients who were coming for their CT scans at a major cancer care hospital in Canada. These patients were mostly ENT surgery patients. Typical neck pathologies were a different kind of thyroid tumors and other head and neck tumors; this does include patients who had previous neck surgeries, who had radiation to their neck or have had some neck masses.

Dr. BobbieJean Sweitzer: So, not necessarily just a patient who was obese or had a thick neck, but actually had some sort of pathologic or surgical pathology?

Dr. Naveed Siddiqui: That’s right.

Dr. BobbieJean Sweitzer: So, who actually determined if the patients were the right ones for this study or how did you recruit patients? And, I guess, even among that group now, people can have surgery or masses but they don’t interfere with the airway particularly or the anterior part of the neck. So, what were the criteria for poorly defined neck landmarks?

Dr. Naveed Siddiqui: So, the neck anatomy of each patient was assessed by an independent anesthesiologist for the degree of difficulty in identifying the neck landmarks according to an established grading system which has been used in different studies.

So, the grading system is defined as grade easy are the ones in which you could visually see the neck landmarks such as prominent thyroid cartilage, grade moderate was defined as somebody who requires light palpation of the neck to identify the landmarks, grade difficult were those individuals in which there is a deep palpation required to identify the neck landmarks and grade impossible was given to those patients in which you were not able to palpate either the thyroid or the cricoid cartilage.

In this particular study, we enrolled patients who had a score of moderate, difficult and impossible neck landmark identification.

Dr. BobbieJean Sweitzer: Got it. So, an independent anesthesiologist who was not later a part of the ultrasound or palpation group was the one who graded these patients initially?

Dr. Naveed Siddiqui: That’s right.

Dr. BobbieJean Sweitzer: And now, who actually performed the ultrasound exams and did the same providers, also were they palpating or you had two separate groups: one doing ultrasound and one doing palpation? And were they on the same patients or on different patients? So, give us some more details about that.

Dr. Naveed Siddiqui: Yes, so the identification of the cricothyroid membrane using either the external palpation or the ultrasound was performed by two anesthesia fellows and this was depending on their schedule and availability. So, these two individuals did either the ultrasound or the external palpation depending on patient randomization.

On the day of the CT scan, this anesthesiology fellow either used a palpation method or the ultrasound method to mark the anticipated entry point using a radiopaque CD-compatible sticker and mark that point. These patients were supine with the neck in the same neutral position as they would went in for their CT scan.

Dr. BobbieJean Sweitzer: So, was that considered the gold standard for location of cricothyroid membrane, the CT scan result?

Dr. Naveed Siddiqui: Traditionally it was the landmark technique that was considered to be the gold standard. Recently the last few years there have been quite a few studies which have used ultrasonography to identify the cricothyroid membrane; however, none of the studies have compared ultrasound to a radiograph or a CT scan to validate the ultrasound imaging and this is what we did in this study.

Dr. BobbieJean Sweitzer: So, you were saying how closely they matched up to what the picture showed…

Dr. Naveed Siddiqui: That’s right.

Dr. BobbieJean Sweitzer: …on the CT?

Dr. Naveed Siddiqui: On the CT scan.
Dr. BobbieJean Sweitzer: Right. So, did you use volunteers for this or were these patients that were going to be having a computed-tomography scan independent of your study?

Dr. Naveed Siddiqui: As was mentioned earlier, we went to a major cancer center hospital, which is not our hospital, but we are located side-by-side; it’s a major referral center for ENT surgery. And these were the patients who were coming here for a follow up after their surgery or initial assessment of their neck pathology. They were in hospitals primarily for their CT scans appointment.

Dr. BobbieJean Sweitzer: And so, what training did the two anesthesiology fellows have before they participated in this study?

Dr. Naveed Siddiqui: So, the anesthesia fellows who were involved in the study received a ten-minute didactic lecture on anatomy followed by a three-minute video of presentation on the ultrasonographic and palpation techniques to identify the anatomical landmarks and the cricothyroid membrane. They were then given hands-on training at least five times with the ultrasound. And as I mentioned, we’ve been conducting a study on this subject for quite some time. So, both these fellows had performed a minimum of 20 successful identification of the cricothyroid membrane using the external palpation and ultrasound which is the required number to achieve competence in ultrasound identification of the cricothyroid membrane.

Dr. BobbieJean Sweitzer: So, we know that for a fact that it requires on average 20 examinations?

Dr. Naveed Siddiqui: Actually, our group published a study on this.

Dr. BobbieJean Sweitzer: Excellent. If one wanted to read more, where was that published?

Dr. Naveed Siddiqui: This was published in an open access journal in BMC Anesthesiology.

Dr. BobbieJean Sweitzer: So, I think you mentioned this at the very beginning, but since we’ve kind of talked about some other things, can you go back and review the anatomy for us; like, where is the cricothyroid membrane if you were trying to describe to somebody who didn’t know anything about the neck? How would they go about palpating or where would they be putting their ultrasound probe?

Dr. Naveed Siddiqui: Sure. So, as we know, the most prominent neck landmark, especially in the males, is the thyroid cartilage. Below the thyroid cartilage is the cricoid cartilage. It is a ring of cartilage that surrounds the trachea. The cricoid cartilage is located slightly below the thyroid which it connects with through the medial cricothyroid ligament. It also joins the first tracheal ring through the cricotracheal ligaments. These cricoid ligaments are basically cricothyroid membrane.

Dr. BobbieJean Sweitzer: Understood.

Dr. Naveed Siddiqui: It is also the space between the inferior border of the thyroid cartilage and the superior border of the cricoid cartilage.

Dr. BobbieJean Sweitzer: And what are we talking about as far as dimensions here?

Dr. Naveed Siddiqui: The cricothyroid membrane—and this is through studies done on human cadavers—have a mean width of 8.2 mm with an upper limit of 11 mm and a mean height of 10 mm with an upper limit of 13 mm. So, these dimensions were done on the cadavers and these fit in a normal person with a regular height.

Dr. BobbieJean Sweitzer: So, about a centimeter-by-centimeter plus minus a millimeter or two?

Dr. Naveed Siddiqui: All is in millimeters, yes.

Dr. BobbieJean Sweitzer: So, is there an optimal way to palpate the neck to identify the cricothyroid membrane? Like, does one start midline? Do you start at the thyroid and move down or how would you tell somebody or teach someone?

Dr. Naveed Siddiqui: So, not much has been described about the optimum way of identifying the cricothyroid membrane. Different methods have been described to locate the cricothyroid membrane such as by palpating the trachea just above the sternal notch and proceed upward until the prominence of the cricothyroid cartilage is identified. Or by palpating the thyroid notch and proceeding downward until the prominence of the thyroid cartilage is identified.

In this study we identified the cricothyroid membrane using the index and middle finger of the nondominant hand to palpate the thyroid cartilage in the middle midline starting from the cephalad and moving orderly to the cricothyroid cartilage.

Dr. BobbieJean Sweitzer: And use the nondominant hand because you assume that if someone’s actually going to be doing a cricothyrotomy they would be holding the instrument in their right hand and palpating with their left hand? Or non…

Dr. Naveed Siddiqui: That’s right.

Dr. BobbieJean Sweitzer: …vice versa, they could be holding with their dominant hand and palpating with their nondominant hand.

Dr. Naveed Siddiqui: That’s right.

Dr. BobbieJean Sweitzer: So, how does one perform an ultrasound examination to locate this membrane?

Dr. Naveed Siddiqui: Two techniques have been described for systematic stepwise identification of the cricothyroid membrane, but one in which you hold the ultrasound probe in a longitudinal direction also known as the ‘string of pearls’ technique.

And the other one is where you hold the ultrasound probe in a transverse orientation and you identify the thyroid cartilage, then you see the airway and then you see the cricoid cartilage. This technique is also called TACA technique. This has been described by a group from Denmark and this has been well-published in literature.

The ‘string of pearls’ technique is the most well-published and has proven its superiority over the transverse technique. For patients with a very short neck or flexion deformity of the neck that leaves no space to palpate the thyroid transducer in the longitudinal position, it is recommended that transverse or the TACA technique to identify cricothyroid membrane as in these set of patients this may be the only successful technique.

You can achieve 100% success rate of identifying the cricothyroid membrane when you combine both the longitudinal and the transverse technique. And, like, the listeners would be able to understand it better if they look at the figures and we have published this stepwise approach with colored pictures in the April edition of this year’s Canadian Journal of Anesthesia.

Dr. BobbieJean Sweitzer: So, there’s not actually pictures in this article that we’re discussing right now, but they can go back to the – an earlier article where you described the technique?

Dr. Naveed Siddiqui: Exactly.

Dr. BobbieJean Sweitzer: And your name is on that previous article if they wanted to Google that?

Dr. Naveed Siddiqui: Yes. It’s in the April edition of the Canadian Journal of Anesthesia.

Dr. BobbieJean Sweitzer: Thank you for mentioning that. So, does one use a typical ultrasound probe that like we would be used to using for a central line placement or a peripheral nerve block? Or is there a special probe that you have to use?

Dr. Naveed Siddiqui: Yes. It is the same ultrasound probe that is used for central venous cannulation or for, like, brachial plexus block. It is used to visualize superficial structures. This is a high-frequency linear probe of 5 to 10 Hz.
Dr. BobbieJean Sweitzer: Tell us what you found.

Dr. Naveed Siddiqui: So, we randomized 223 patients, [109] to the external palpation group and 114 in the ultrasound group. More than half of the patients in each group had previous neck surgeries. The patient characteristics were similar between the two groups except for a small difference in the BMI.

Our primary outcome was the accuracy and identification of the cricothyroid membrane which was measured by a digital ruler in millimeters from the center point of the cricothyroid membrane identified at the CT scan.

So, we measured the distance between the middle of the cricothyroid membrane identified through the CT scan to the distance where the point was marked using external palpation and to the point where ultrasound determined that this is the center point of the cricothyroid membrane.

We defined success as the proportion of accurate attempts within a 5-mm distance from the center of the CT point to the ultrasound point or the external palpation point.

So, the proportion of accurate attempts defined as a distance of 5 mm or less was tenfold greater in the ultrasound probe; that is 81% versus in the external palpation group it was only 8% and this was statistically significant.

The other important finding was the distance that was measured from the external palpation to the CT scan point was five times greater as compared to the ultrasound point and the risk ratio of inaccurate localization of the cricothyroid membrane was ninefold greater with the external palpation than with the ultrasonography and this was statistically significant as well.

Dr. BobbieJean Sweitzer: You mentioned how it’s statistically significant and I assume you chose the 5 mm because that suggests, perhaps, if one is off that much it’s a problem. But was the accuracy of the measurement by ultrasound clinically significant?

And I guess what I’m asking is, would ultrasound actually make a difference? I know you didn’t study the actual performance of cricothyrotomies in these patients, but could you postulate or predict that this difference in ultrasound would have been the difference between success or failure?

Dr. Naveed Siddiqui: That’s right. Not in this study we did the performance but in our previous study that was published in 2015 in Anesthesiology—and this was a cadaver study—we actually performed the procedure; the two groups there were ultrasound-guided versus external palpation, and we showed that there was a significantly high incidence of injury to the larynx and trachea using the palpation technique as compared to the ultrasonography. And there was a relative risk reduction of almost 3% between the two techniques.

The use of ultrasound increased the probability of correct insertion by 5.6 times in cadavers with difficult and impossible landmark palpation. And to put it into the context, there are some new published reports in which ultrasonography was used to identify and mark the cricothyroid membrane before the start of anesthesia and then they used the same point and successfully did the cricothyrotomy without complications.

Dr. BobbieJean Sweitzer: Did you measure the time it took to do an ultrasound identification?

Dr. Naveed Siddiqui: No, not in this study; however, in previous studies we have measured the time duration to mark the cricothyroid membrane using ultrasound and palpation and as expected it takes longer to perform the ultrasound.

However, practice of ultrasound scanning not only reduces the time but also improves your ability to identify difficult neck landmarks. This was the case in another study from our group which coincidentally was published in the same December issue of Anesthesia & Analgesia.

We tested the ability of anesthesia participants to identify the midpoint of the cricothyroid membrane using the external palpation with and without ultrasound-guided practice. Anesthesia participants exposed to practice with ultrasound-guided palpation of cricothyroid membrane location was better able to identify the cricothyroid membrane using only blind palpation than participants without ultrasound-guided practice.

Practice with ultrasound-guided palpation of neck landmark improved subsequent blind localization of the cricothyroid membrane using palpation alone. So, this just came out in the December issue of Anesthesia & Analgesia.
Dr. BobbieJean Sweitzer: It sounds like you’ve studied a variety of patients and a variety of situations.

Dr. Naveed Siddiqui: Well, we are a high-risk obstetric unit, so obstetric is our main population.

Dr. BobbieJean Sweitzer: And that’s an important population because those patients notoriously we know may be difficult to intubate, difficult to ventilate and...

Dr. Naveed Siddiqui: Indeed.

Dr. BobbieJean Sweitzer: ...often in the situations you need to need to do that, there’s a real urgency to it as well.

Dr. Naveed Siddiqui: That’s right.

Dr. BobbieJean Sweitzer: So, is it realistic that in a situation of cannot intubate, cannot oxygenate that one can effectively, efficiently perform ultrasound to assist with emergency cricothyroidotomy?

Dr. Naveed Siddiqui: This is the point: cricothyroidotomy is done in an emergency situation as per all airway algorithms. However, in patients with anticipated difficult airways, the algorithm, the emphasis on better preparedness, that includes preparedness for the surgical airway. So, we are educating that you should premark the cricothyroid membrane using ultrasound before induction of anesthesia respective of whatever method of intubation you use.

Dr. BobbieJean Sweitzer: That would make sense.

Dr. Naveed Siddiqui: It has to be done pre – like, not at the time when your patient is desaturating. It should be done as a preparatory step.

Dr. BobbieJean Sweitzer: Yes, just like you make sure you have the other – Plan B, Plan C or – and you have your fiberoptic available and your – you just do this as part of that set up.

Dr. Naveed Siddiqui: Exactly.

Dr. BobbieJean Sweitzer: So, I think you mentioned a little bit about the injury risk of cricothyroidotomy. So, it’s not just failure to establish an airway, but also in doing so do you actually cause other kinds of injuries. Were you able to look at that in this study or other studies that you – of the likelihood that using ultrasound would also make this a safer procedure via decreasing complications such as vascular injuries or injuries of vocal cords?

Dr. Naveed Siddiqui: Yes, definitely. And this is exactly what we find out in our previous study done on human cadavers that injuries associated with larynx and trachea and even esophageal perforation were absent in the group that used ultrasound for identification of the cricothyroid membrane or in that particular study it was a performance of the cricothyrotomy. And so, ultrasound reduced the incidents of the injuries to the larynx and trachea.

Dr. BobbieJean Sweitzer: I assume that trauma surgeons, the ENT surgeons, even emergency room department physicians probably perform more cricothyroidotomies that anesthesiologists do. Do we know anything about ultrasound use in – by those groups of people and the success or benefits of it?

Dr. Naveed Siddiqui: Yes. In fact, there is a publication on this subject and unfortunately neither anesthesiologists nor the trauma surgeons are good in identifying the cricothyroid membrane. The overall success rate using palpation to identify the cricothyroid membrane in that publication was less than 50% and there were no differences in success rate between anesthesia providers and trauma surgeons.

Dr. BobbieJean Sweitzer: Interesting.

Dr. Naveed Siddiqui: And it was 16% success by anesthesia providers and 26% success by the trauma surgeons.

Dr. BobbieJean Sweitzer: Wow, not very good. So, should we be training anesthesiology residents or even attendings to routinely perform neck ultrasound?

Dr. Naveed Siddiqui: Absolutely. We at our institute have already started to train residents and fellows how to use ultrasound for various indications and it seems like learning ultrasonography is going to be one of the most important skills for anesthesia trainees now and in the future.

Dr. BobbieJean Sweitzer: It does seem to be revolutionizing our practice. So, what exactly is the curriculum for the neck ultrasound specifically that your residents get exposed to?

Dr. Naveed Siddiqui: So, first of all they get a revision tutorial, a didactic teaching about the anatomy of the upper airway specifically related to the performance of surgical airway, both cricothyroidotomy and tracheostomies. And then they get a hands-on session to learn the technique, how to identify the exact space, cricothyroid membrane using both the transverse and the longitudinal methods of upper airway ultrasonography.

Dr. BobbieJean Sweitzer: And you do this in a simulated setting or with cadavers or you do it, like, in anesthetized patients?

Dr. Naveed Siddiqui: We do it on volunteers and if they are part of a study, then, yes, they would go into the simulation center. But not as a routine.

Dr. BobbieJean Sweitzer: Sounds very valuable. So, I hope today’s discussion will interest many of our listeners and lead you to read this important article to learn more. Thank you, Dr. Siddiqui, for discussing your work with us today. I wish you well as you continue your efforts to enhance the practice of anesthesiology and strive to improve the care of our patients.

Dr. Naveed Siddiqui: Thank you very much for giving me the opportunity.

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