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Original scientific paper

The Role of Videofluoroscopy and Ultrasound in Assessing Pharyngoesophageal Muscle Tone after Laryngectomy

Robert Tićac[1], Barbara Čandrlić[2], Jurica Juranić[3], Goran Pavelić, Dijana Pedisić[1,] Marin Pušić[2], Marko Velepič[1], Radan Starčević[1] and Damir Miletić[2]

[1] University of Rijeka, Rijeka University Hospital Center, Department of Otorhinolaryngology, Rijeka, Croatia
[2] University of Rijeka, Rijeka University Hospital Center, Department of Radiology, Rijeka, Croatia
[3] University of Rijeka, Rijeka University Hospital Center, Department of Anesthesiology and Intensive Care Medicine, Rijeka, Croatia

A B S T R A C T

The aim of this study was to compare the respective value of videofluoroscopy and ultrasound for assessment of the tonicity of the neoglottis and determination of the exact neolaryngeal segment of hypertonicity. We examined twelve patients who had developed inadequate tracheoesophageal voice following total laryngectomy and installation of tracheoesophageal prosthesis. We assumed that the cause of the unsatisfactory voice quality in our patients was neolaryngeal muscle spasm[2,12–13]. After determining the exact hypertonic segment, we administered lidocaine intramuscularly and tried to act on the hypertonic segment. By means of videofluoroscopy as gold standard[1,6] for comparison with ultrasound examination, we followed the passage of contrast through the neo-larynx and watched for dilatation of the segment during swallowing, phonation and at rest to determine whether there were any tonus disturbances or differences before and after lidocaine injection. In conclusion, a combination of the two methods could yield better results in voice restoration. Videofluoroscopy is the method of choice for initial assessment and determination of the hypertonic segment, while ultrasound is the method to apply to facilitate administering the drug more precisely.

Key words: *laryngectomy, tracheoesophageal prosthesis, neo-larynx, lidocaine, hypertonic spasm*

Introduction

One of the major problems that patients encounter after total laryngectomy is voice restoration. The most commonly used method for voice restoration is surgery, which enables tracheoesophageal (TE) speech. Tracheoesophageal voice restoration has become the method of choice after total laryngectomy[9,10]. Up to 94% of patients acquire a fair to excellent voice [1,8]. The basic principle is to create a surgical fistula or tract between the trachea and the oesophagus which will allow the air from the lungs to pass into the oesophagus[1,2]. The air exhaled from the lungs then vibrates the pharyngoesophageal (PE) segment to produce the sound[2]. The problem is that in some patients the produced voice is of low or very low quality. The quality of the produced sound depends mostly on the resistance to the airflow, which correlates to muscle tonicity in the PE segment[12–14].

The aim of this study was to show our experience in comparing the respective value of videofluoroscopy and ultrasound for assessing the tonicity of the neoglottis and determining the exact neolaryngeal segment of the disturbed tonus. Videofluoroscopy is the method of choice for determining the presence of hypertonicity and assessing the length of the hypertonic PE segment[1,6]. Ultrasound could be a cheap and promising method for evaluating the tonicity of the neoglottis without any radiation[13,14].

We examined patients who had developed inadequate tracheoesophageal voice following total laryngectomy and installation of tracheoesophageal prosthesis. We assumed that the cause of the unsatisfactory speech results in our patients was neolaryngeal muscle spasm[2,3,12,13]. Af-

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ter determining the exact hypertonic segment, we administered lidocaine intramuscularly and tried to act on the hypertonic segment[7,14].

Material and Methods

In our institution, two hundred laryngectomised patients had a tracheoesophageal fistula created and prosthesis inserted for vocal restoration; in twelve out of them, the expected tracheoesophageal voice quality was not achieved. These twelve were treated over the period of one year. Firstly, all patients underwent ultrasound examination of the neolaryngeal region during swallowing, phonation and at rest. The ultrasound criterion for hypertonia was extreme dilatation of the oesophagus below the level of the TE prosthesis during forced phonation (Figure 5)[1]. The neolaryngeal hypertonicity caused most of the airflow to go in the opposite direction from the esophagus, which resulted in its extreme dilatation. In patients with suspected hypertonicity, we marked the cranial and caudal parts of the hypertonic segment with a marker. After ultrasonography, videofluoroscopy was used as the gold standard to determine if there were any tonus disturbances. It was used to follow the passage of Barium contrast through the neo-larynx and observe the dilatation of the neolaryngeal segment during swallowing, phonation and at rest.

Tonus disturbance, classified as hypertonicity or spasm, was diagnosed if there was a narrow stripe of oral contrast during swallowing and a totally closed neo-larynx during phonation with the thumb on the tracheostomy (Figures 1, 2 and 3)[3].

Fig. 1. X-ray film, lateral view showing an almost fully closed neo-larynx at rest, before lidocaine injection.

Fig. 2. Lateral x-ray showing poor dilatation of the neo-larynx during forced phonation. The hypertonic pharyngeal segment resulted in poor voice.

Fig. 3. X-ray film, lateral view showing an almost fully closed neo-larynx during swallowing.

At the end of videofluoroscopy, we used a radiopaque marker in all patients with suspected hypertonicity to mark the cranial and caudal parts of the hypertonic segment. Marking was also used in two patients without obvious signs of hypertonicity to trace the most cranial and the most caudal parts of the neo-larynx. (Figure 4).

After determining the size of the neo-larynx in all patients, in half of them lidocaine was administered locally

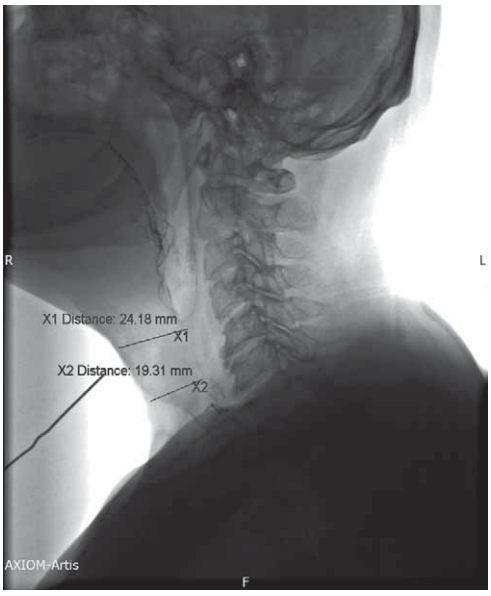

Fig. 4. Lateral x-ray before lidocaine injected, measuring the spastic segment of the neo-larynx with radiopaque marker.

Fig. 6. Lateral x-ray of a dilated neo-larynx after lidocaine injection. Satisfactory voice improvement was achieved.

under videofluoroscopy using muscle stimulator and free technique. The other half was administered lidocaine using ultrasound real-time imaging, rather than muscle stimulator, to detect the muscles of the neo-larynx.

A total of 10–15 mL of 2% lidocaine was administered close to the PE muscles. Ten minutes after lidocaine administration, the examinations were repeated applying the same technique used for the initial lidocaine injection.

With either technique, a good response to lidocaine injection was defined as dilatation of the neolaryngeal segment during swallowing and forced phonation that was greater than before the injection (Figure 6). We had no major complications during the procedure with either technique.

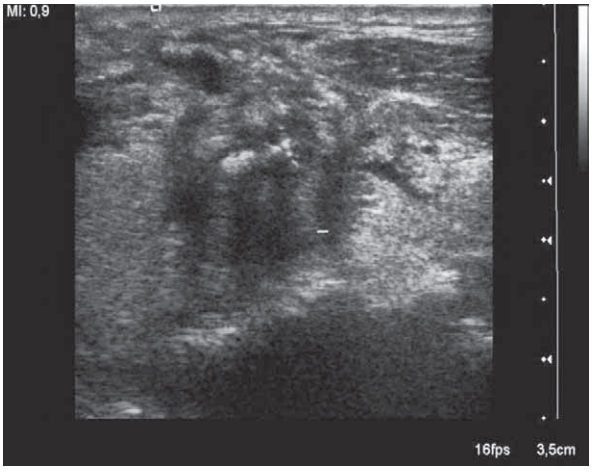

Fig. 5. Axial ultrasound picture presenting dilated oesophagus below a TE prosthesis after forced phonation as a sign of proximal spasm.

Results

Of the twelve subjects examined, ten presented with hypertonicity on videofluoroscopy, while ultrasonography showed a strong suspicion of hypertonicity in only five of them. The determination of the most cranial and the most caudal parts of the hypertonic segment by these two techniques differed by 1 cm, however, which is unsatisfactory. In the five patients without obvious ultrasonographic signs of hypertonicity, post-radiating fibrosis and postoperative changes precluded complete examination.

Of the ten patients with hypertonicity diagnosed by videofluoroscopy, eight developed a satisfactory tracheoesophageal voice approximately ten minutes after drug administration, all of them also showing a better relaxation of the neo-larynx during phonation. Of these eight, five developed better voice permanently – three having had lidocaine injected under fluoroscopy and two under ultrasound control. The remaining three had an improved voice only during the action of lidocaine only.

Two of the twelve patients, one from either group, failed to improve voice altogether. On control examinations, they did not show any differences in the neo-larynx before and after the procedure. One of the two patients who showed no radiological signs of hypertonicity with either method did manage to achieve a better voice quality, but only during the action of lidocaine, presumably conditioned by the psychological moment, but the other did not demonstrate any significant voice rehabilitation.

Discussion and Conclusion

Our study confirmed the hypothesis that the probable cause of inadequate speech in our patients is the hypertonicity of the tracheoesophageal segment[12,13]. Such claim

stems from the fact that lidocaine administration in the region of the hypertonic segment resulted in the relaxation of the segment and improved speech. We believe that the improvement of the speech obtained in one of the two of our patients who did not show any signs of hypertonicity may be ascribed to a psychological cause, i.e., the probable placebo effect. We tried to demonstrate that for assessment of the presence and length of a hypertonic segment, ultrasound is just as good a method as videofluoroscopy. In fact, we assumed that ultrasound, which is widely used in the diagnosis of diseases of the neck organ, is simple to use and does not carry the risk of excessive exposure of patients to radiation, may be potentially useful for our purpose as well[12,13]. Our conclusion is that it is a method which can facilitate local application of lidocaine directly into the muscle of the neo-larynx owing to the real-time visualisation and a clear view of vascular and other structures, which reduces the risk of complications. On the other hand, ultrasound requires a better cooperation on the part of the patient, and the quality of the picture is highly dependent on post-radiation changes, frequently substantial in our patients. This may well be one of the reasons why, in our study, ultrasound confirmed hypertonicity in only 50% of our patients as compared to videofluoroscopy. The results might have been somewhat better if the group of examined patients had been bigger, given that all our patients had had radiotherapy and suffered significant post-radiation changes.

In conclusion, we confirmed that videofluoroscopy is the gold method for assessing and recognising hypertonicity of the neo-larynx. Ultrasound may be used as an easily available method for real-time visualisation of neo-laryngeal and vascular structures with a view to a more precise and safer administration of lidocaine than can be achieved using muscle stimulators.

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B. Čandrlić

University of Rijeka, Rijeka University Hospital Center, Department of Radiology, Krešimirova 42, 51000 Rijeka, Croatia
e-mail: barbaracandrlic@yahoo.com

ULOGA VIDEOFLUOROSKOPIJE I ULTRAZVUKA U PROCJENI TONUSA FARINGOEZOFAGEALNE MUSKULATURE NAKON LARINGEKTOMIJE

SAŽETAK

Prikazali smo naša iskustva, te usporedili vrijednost videofloroskopije i ultrazvuka kod procjene tonusa i određivanja točnog segmenta hipertonusa faringoezofagealne muskulature, nakon laringektomije i ugradnje traheoezofagealne proteze, kako bismo medikametozno, lidokainom, anatomski što preciznije, pokušali djelovati na hipertonični segment. Pretpostavili smo da je uzrok nezadovoljavajućeg govora naših pacijenata hipertonus muskulature neolaringsa. Od dvijestotinjak pacijenata kod kojih je učinjena laringektomija i implantacija govorne traheoezofagealne proteze njih 12 nije razvilo zadovoljavajući govor. Videofluoroskopski i sonografski pratili smo prolazak kontrasta neolaringsom prije i za vrijeme fonacije kako bismo odredili hipertonični segment ukoliko postoji. Nakon aplikacije lokalnog anestetika videofluoroskopski i ultrazvučno smo uočili smanjenje hipertonusa kod onih pacijenata s hipertonusom. Zaključno, kombinacijom videofluoroskopije kao metode izbora za procjenu i određivanje hipertoničnog segmenta te utz-ka kao metode pod čijom se kontrolom aplicira lidokain možemo preciznije i ciljano aplicirati lijek i time pospješiti govornu rehabilitaciju.