ORIGINAL ARTICLE

SURGICAL TECHNOLOGIES USED IN THE APPROACH OF THE SUPRACLAVICULAR FOSSA

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Abstract

The supraclavicular fossa is an area of great surgical interest but difficult to approach due to the abundance of vascular and nervous elements found at this level. With the development of new technologies, the surgeon gains greater safety in the wound by reducing the operating time, the degree of bleeding, as well as by obtaining better control over the anatomical elements found in this area and reducing the risk of perioperative complications. This paper aims to express the results about surgical technologies used in the approach of the supraclavicular fossa obtained from quantitative and qualitative analysis after an observational and descriptive study, in which data collection was done retrospectively (data was collected from medical observation charts and operating protocols which dated before the start of the study) and prospectively (patients were admitted to the study after the study began), *conducted in "Prof. Dr. D. Hociotă" Institute of Phonoaudiology and Functional ENT Surgery, between 2010 and 2021. The use and control of surgical technologies encountered in the study is directly dependent on the accessibility and experience of the surgeon and must involve constant analysis of the benefit of their use at the expense of risks and possible complications that may occur.*

Keywords*: supraclavicular fossa, surgical technologies, supraclavicular surgical approach*

Introduction

The supraclavicular fossa is an anatomical and surgical region known to describe the posterior cervical triangle, comprising major anatomical risk elements which represent a test of surgical endurance and thoroughness. This anatomical and surgical space is small in size but the abundance of vascular, nervous and lymphatic structures that define it gather in a bundle from upper to lower, towards the upper thoracic opening [1].

The elements of the supraclavicular fossa, from anterior to posterior, are essentially represented by: the subclavian vein, the transverse cervical vein, the subclavian artery, the suprascapular artery, the transverse cervical artery, the phrenic nerve, the superior trunk of the brachial plexus and the transverse cervical lymphatic chain. All these mentioned anatomical structures are stratified on planes delimited by the position of the scalene muscles, the position towards the superficial cervical fascia, the infrahyoid muscles and the pretracheal lamina of the cervical fascia [1],[2].

Thus, the pathological lesions found at the site of the supraclavicular fossa may have originated either at the level of any of the anatomical

elements found here or at the level of the neighboring anatomical elements. Also, the pathological lesions at the level of the supraclavicular fossa can represent secondary determinations of some systemic pathological processes or of other distance located organs [2].
The surgical approach of the pathologies found at this level involves a detailed preoperative evaluation to guide the surgeon regarding the origin of the pathological structure and to help decide the optimal operative moment as well as the proper surgical technologies used for local dissection and hemostasis.
With the development of new technologies, the surgeon gains greater safety in the wound by reducing the operating time, the degree of bleeding, as well as by obtaining better control over the anatomical elements found in this area and reducing the risk of perioperative complications
A basic tool of surgical practice, the bipolar electrocautery's techology is based on the prototype of the electrosurgical unit designed by William Bovie in the early 20s that favored the body passage of high frequency alternative current and allowed it to perform cutting or coagulating the tissues [3].
The bipolar electrocautery, developed as surgical technology over the last decades, is used with increasing prevalence in head and neck surgical procedures [4].
The electrical current that crosses the region where this technology is applied, produces an increased local heat that damages tissues causing a series of complications such as: local burns due to improper application of the device, fires as well as the occurrence of electromagnetic interference with cardiac monitoring devices or pacing [5],
Although the applicability of this technology is increased in all branches of surgery, the local thermal effect produced by its use has led medical engineering to seek and develop new dissection and hemostasis technologies whose usefulness is to reduce adverse effects on tissues, perioperative incidents, duration of dissection and hemostasis, as well as the amount of blood lost intraoperatively.
Radiofrequency is a technology that is based on high frequency radio waves, capable of producing incisions with very high accuracy. The frequencies used by this technology are 4 MHz, below the FM spectrum, but above the AM spectrum.
Out of a desire to limit the damage caused to neighboring tissues, Irving Ellman, a dentist and electronics engineer, created a generator with a 4 MHz circuit that produced a wave of pure filtrates, thus laying the foundations of the technology used so far.
While the components of this device are a generator and two metal plates, the operating modes of the radiofrequency device are represented by CUT, CUT / COAG, HEMO, FULGURATION and BIPOLAR [6],[7].
The radiofrequency technology includes the ability to incise and obtain concomitant hemostasis, without the need to apply pressure, thus reducing tissue trauma.
The LigaSureTM technology represents a modern surgical device that is used both for incision and dissection of tissues and for sealing blood vessels.
The LigaSure TM device is composed by 3 elementes: a generator, a surgical forceps that may vary in shape depending on the type of surgery and an activation pedal.
The LigaSureTM concept was based on the bipolar electrothermal system for sealing blood vessels. When developing the device, a modified mnodel of bipolar electrosurgical technology, developed in the early 1940s, was used and improved in order to reduce tissue burns and have the ability to seal vessels up to 7 millimeters in caliber. The seal produced by LigasureTM can resists to an increase of up to 3 times the systolic blood pressure [8],[9].
HarmonicTM technology has been developed since the early 1990s as an alternative to classical hemostasis achieved by ligation with sutures. This system performs both hemostasis and tissue incision.
HarmonicTM Scalpel components are represented by a generator, a handpiece and two blades.
The generator is controlled by a microprocessor and has the role of transforming electricity into mechanical energy, namely ultrasound.
Depending on the desired coagulation intensity, the level at which the generator is set can be adjusted. The coagulation performed by this device is dependent on the interaction between the tissue and the ultrasonic energy, which practically translates into the fact that when the

cutting speed increases, the degree of coagulation decreases and vice versa [10].
The use of the Harmonic technology has its advantages translated by the decrease of surgical time due to the ability to cut and coagulate simultaneously, lowering the amount of blood lost intraoperatively, decreasing thermal tissue damage that causes faster reepithelialization as well as reducing the patient's postoperative recovery time and admission period [11].

Materials and Methods

The study in question is an observational and descriptive study, data collection being done retrospectively (data was collected from medical observation charts and operating protocols which dated before the start of the study) and prospectively (patients were admitted to the study after the study began), making reference to representative clinical situations, techniques, technologies and surgical materials found and used in "Prof. Dr. D. Hociotă" Institute of Phonoaudiology and Functional ENT Surgery and being carried out over a period of time between 2010 and 2021. The study group consisted of 71 patients with pathological lesions found in the supraclavicular fossa. This group of patients was extracted from a volume of 1952 cases of extraluminal cervical pathology (excluding endoluminal pharyngeal, laryngeal, tracheal and cervical esophageal lesions) from the casuistry found in "Prof. Dr. D. Hociotă" Institute of Phonoaudiology and Functional ENT Surgery, during the period of time mentioned above.

The study focused on quantitative aspects by collecting and developing a statistical analysis of data extracted from the study group, as well as qualitative aspects that expose elements of surgical progress highlighted in terms of the surgical approach of the supraclavicular fossa.

The inclusion criteria in the study were represented by:
1. Pathologies located in the supraclavicular fossa (primary or secondary lesions);
2. Absence of comorbidities that contraindicate the operative moment (such as: oncological cases with extension to the cervical spine / inoperable malignant tumors of the pulmonary apex irradiated, polychemotreated, "fixed" / oncological cases with uni -/ polytope metastases that do not respond to specific oncological therapy);
3. Absence of contraindications related to the administration of anesthetics;
4. Patients clinically and biologically compensated for surgery
5. Obtaining the informed consent of the patient / relative for surgery and anesthesia.
The exclusion criteria from the study were represented by:
1. Significant comorbidities that contraindicate the surgical act, analyzing the risk-benefit ratio of the patient's health, on a short / medium / long term;
2. Anesthetic-surgical risk that cannot be improved prior to the operative moment;
3. Not obtaining the informed consent of the patient / relative for surgery and anesthesia.
The research instrument used in this study is represented by a case analysis protocol for primary or secondary supraclavicular pathology, an original concept that was personally designed for the patients taken in study in order to detect the qualitative aspects of surgical techniques and technologies used in supraclavicular pathology. This protocol was reviewed at the end of the study to see if it could be completed and was categorized as an open protocol for the incorporation of elements of surgical technique and technology, as well as of some materials / biomaterials and complementary therapies presented as topical elements by other authors in literature.

The data collected in this study were entered into the Microsoft Office Excel program, and then the database was recoded in SPSS format (using the SPSS 23.0 program) in order to be able to perform the statistical analysis of the data collected in the study.
The database of the study was obtained by using the observation sheets of the patients hospitalized in "Prof. Dr. D. Hociotă" Institute of Phonoaudiology and Functional ENT Surgery, during 2010-2021, the operating protocols from this period, as well as by applying the case analysis protocol mentioned above.

Results

There is a need for clarification before expressing the results of the study regarding the technologies

used in the surgical approach of the supraclavicular fossa pathologies.

Eleven out of the 71 patients taken in the study did not receive surgery under general anesthesia because:

- two patients presented with abscessed supraclavicular skin lesions that benefited from an aspiration and drainage under local anesthesia with subsequent remission of symptoms and
- nine patients with secondary supraclavicular tumors suspected to be a metastatic expression of another known primary tumor were redirected to evaluation by the Oncology Commission because, after detailed preoperative assessment, patients decided to refuse to sign the consent for surgery and general anesthesia.

Out of the 60 patients that underwent surgical treatment, 14 had surgical indication for exploratory cervicotomy with biopsy sampling, and for 46 patients a cervicotomy with ablation of the lesion was performed. All excised materials were sent for histopathological examination.

The distribution of patients according to the surgical technology used is heterogeneous ($p < 0.001$). In the majority of patients taken into the study (36) cold instruments and bipolar electrocautery were used, another 17 patients had surgery in which cold instruments and radiofrequency were used. On 5 patients, surgery implied using cold instruments and LigaSureTM Small Jaw forceps, while only 2 patients underwent a surgical procedure that implied the use of cold instruments and HarmonicTM Focus forceps (Figure 1).

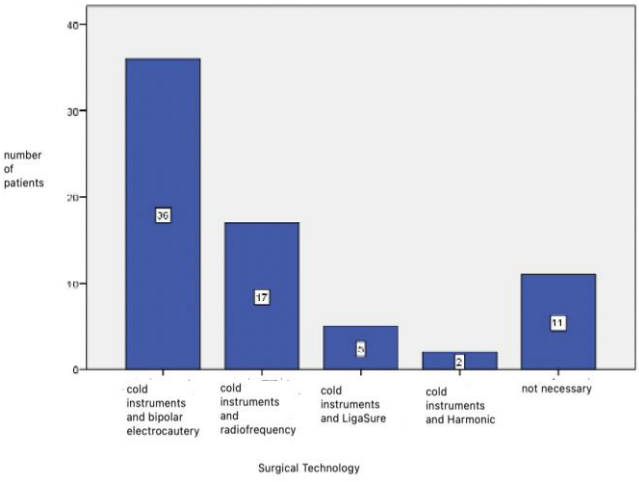

Figure 1 - Distribution of patients according to the surgical technology used

When discussing surgery of malignant supraclavicular tumors, cold instruments and bipolar electrocautery were used in 50.00% of patients, cold instruments and radiofrequency in 18.75% of patients, cold instruments and LigaSureTM Small Jaw for 8.33% of patients and cold instruments and HarmonicTM Focus forceps were used in 4.17% of patients.

In case of surgery for benign supraclavicular tumors, cold instruments and bipolar electrocautery were used in 52.17% of patients, cold instruments and radiofrequency in 34.78% of patients and cold instruments and LigaSureTM Small Jaw forceps in 4.35% of patients.

Skin and fascial incision, as well as some neural and vascular operative dissection sequences, were performed with the radiofrequency needle, in almost all cases studied. There is no significant statistical difference between the surgical technologies used depending on the type of supraclavicular tumor (malignant/benign) (Figure2).

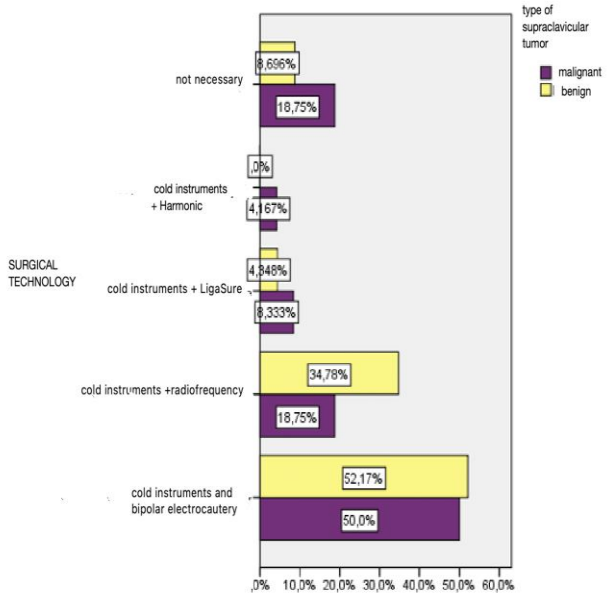

Figure 2 - Surgical technology used according to the type of supraclavicular tumor

There was no statistic difference ($p = 0.991$) considering the average duration of surgery in patients for which the surgical treatment included the use of cold instruments and bipolar electrocautery (107.91 ± 44.35 min), cold instruments and radiofrequency (107.64 ± 52.77 min), cold instruments and LigaSureTM Small Jaw forceps (110.00 ± 30.21 min) as well as for

those in which there were used cold instruments and HarmonicTM Focus forceps (97.50 ± 81.32 min) (Figure 3).

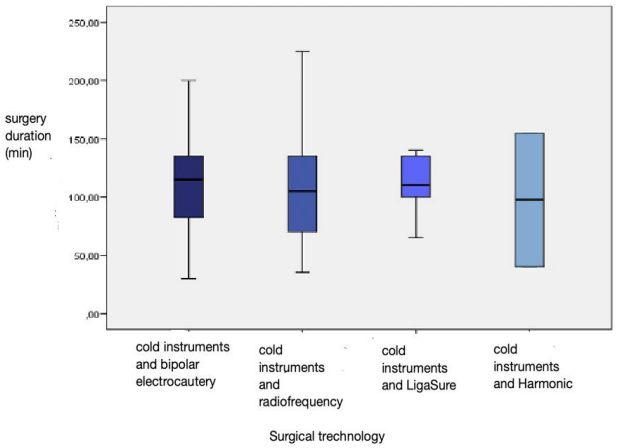

Figure 3 - Duration of surgery depending on the surgical technology

There is no significant statistical difference on the occurrence of perioperative complications depending on the surgical technology used (p = 0.662) (Figure 4).

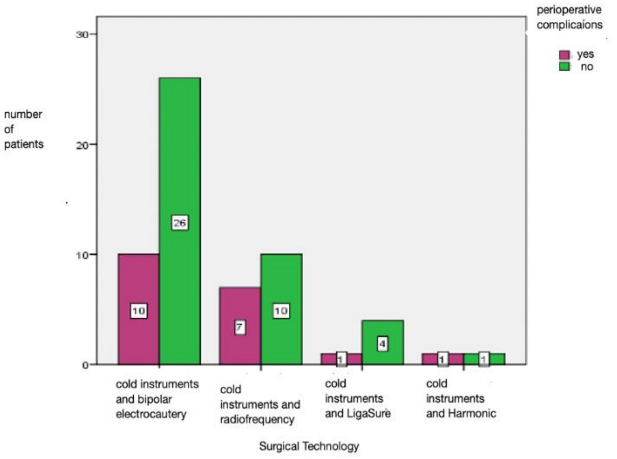

Figure 4 - Occurrence of perioperative complications depending on the surgical technology used

Also, there was no statistical difference (p = 0.434) encountered in terms of mean intraoperative bleeding in patients treated with cold instruments and bipolar electrocautery (110.55 ± 38.39 ml), cold instruments and radiofrequency (98.82 ± 40.56 ml), p cold instruments and LigaSureTM Small Jaw forceps (95.00 ± 5.00 ml) and those with cold instruments and HarmonicTM Focus forceps (95.00 ± 7.07 ml) (Figure 5).

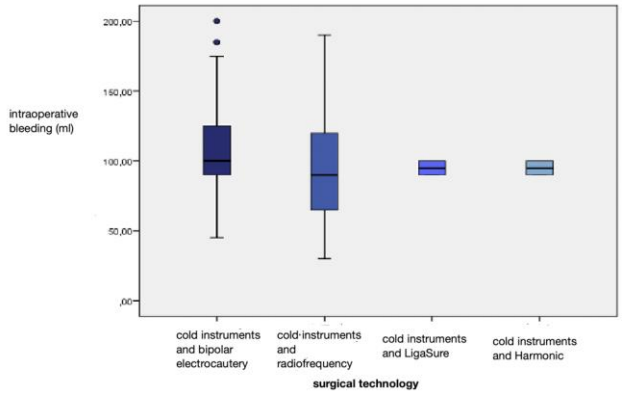

Figure 5 - The volume of intraoperative bleeding depending on the surgical technology

The postoperative complications, according to the surgical technology used, were as follows:
- bleeding exteriorized at the site of the surgical wound (1 patient), seroma (8 patients) and vocal cord hypomobility (1 patient), if surgery has been performed using cold instruments and bipolar electrocautery;
- bleeding exteriorized at the site of the surgical wound (1 patient), serum (2 patients), minimal bleeding at the site of the wound (1 patient), lymphorrhagia by lymphatic duct injury (1 patient) and superior vena cava syndrome (1 patient), if surgery has been performed with cold instruments and radiofrequency;
- seroma (2 patients) if surgery has been performed using cold instruments and LigasureTM Small Jaw forceps;
- lymphorrhagia by lymphatic duct injury (1 patient), if surgery has been performed using cold instruments and HarmonicTM Focus forceps.

Discussions

In conducting the study, we used radiofrequency in 17 of the cases analyzed.
Radiofrequency is not a complex technology as a way of use, but it implies a knowledge of certain technical elements as well as well as a surgeon's learning curve regarding the instrument provided by this technology in order to control and obtain optimal surgical results.
It should be emphasized that radiofrequency is a cold technology that does not produce a thermal effect when interacting with the tissue hence its elective use in intrafascial, perineural and perivascular dissection. The power intensity of the radiofrequency device needs specific

adjustments according to the area of surgical interest, the type of surgery and particular local conditions such as the existence of fibrous tissue, type and abundance of blood supplies and nerve structures. Setting an incorrect intensity can determine intraoperative complications such as local tissue necrosis, poor managed hemostasis, or even electrode tissue adhesion that does not allow a good quality incision to be made [6].

To obtain a good quality incision by using radiofrequency is necessary to apply minimum and uniform pressure simultaneously. It is required, in order not to cause tissue necrosis, to avoid intraoperative movements with radiofrequency that are too slow as well as the successive use, without maintaining a pause of at least 10 seconds, of the electrode on the same structure. There is a secondary heat effect that appears from tissue resistance to the passage of radio waves, but this type of heat is usually of low intensity and does not determine thermal lesions [7].

One of the disadvantages of radiofrequency is represented by the smoke released at the time of use, as as a final expression of the effect of radiofrequency on tissues. As it may be composed of toxic gases and various quantity of viruses this type of smoke was shown to be harmful to surgeons and the team involved at the time of surgery.

The radiofrequency device should not be used in patients that have an older generation pacemaker of defibrillator as it may influence their proper functioning pattern.

Radiofrequency gives the possibility of good intrafascial dissection sparing local small nerve structures such as brachial plexus branches [6].

This type of surgical technology that uses radiofrequency is considered to be a cold technology in terms of tissue interaction, reducing the risk of vascular injury achieved by thermal effect as opposed to the use of the bipolar electrocautery [4],[5],

In the presented study, the use of Ligasure TM technology was found in 5 of the cases analyzed. This technological device is optimized so it produces a minimal thermal spread at the site of the neighbouring tissues, almost 2 millimeters, and so avoiding its carbonization. In this way the LigaSure system diminishes the risk of thermal injury that may affect critical anatomical structures in the vicinity of the injured blood vessel.

The LigasureTM forceps has a cutting function, independent of the blood vessel sealing function. This cutting function shortens the duration of surgery and, due to its shape, the forceps can access anatomical areas with low visibility [6].

The disadvantage of the LigaSureTM technology is that each forceps is a disposable instrument that has high costs which are to be paid by the patient [9].

We have little experience in using this device and the use of this technological instrument requires further study and developments in our surgical practice.

In the mentioned study, we used HarmonicTM technology in 2 of the cases analyzed.

HarmonicTM technology ensures a time-dependent coagulation, this being related to the interaction between the tissue of surgical interest and the ultrasonic energy. When this aspect needs to be put into practice, it reflects the smooth transition between dissection and coagulation. As the dissection rate increases, coagulation decreases as well as when the dissection rate decreases, coagulation increases [10], [11].

Similar to LigasureTM technology, our experience in using this device is still in limited and requires further study and development in our surgical practice.

Conclusion

A profile of electively used today surgical technologies was determined in “Prof. Dr. D. Hociotă” Institute of Phonoaudiology and Functional ENT Surgery, reffering to the surgical technologies mentioned in the speciality literature. Qualitative and specific observations were made to reinforce this prior statement. The most effective approaches we have chosen in our surgical practice have proven to be radiofrequency surgical technologies.

The main features of the mentioned profile of surgical dissection technology used in the supraclavicular fossa and highlighted through our study are represented by: instruments that use cold technology ("low temperature"that does not express effects on the surrounding tissues), fine instruments (either dissection needles with a

blunt tip, fine bipolar cautery as well as fine loops that use radiofrequency and have flexible handles).

From our study we observed that the monopolar cautery with aspiration cannula is to be avoided due to the "thermal cone" effect that this instrument can determine in the paravascular spaces as well as over the pleural dome.

In case of need for vascular cauterization in the surgical field during our study we used bipolar electrocautery and / or radiocautery.

The surgeon's experience and learning curve dictate both the manuality with which he handles the instruments as well as the control he manages to develop over the surgical field. Thus, by visualizing the potential perioperative risks and having the ability to discriminate between technological options, the surgeon will look for the most feasible and adaptable option to the pathological situation and anatomical area of surgical interest.

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