Article

Our First Experience of Using Blue Light Laser for Endoscopic Endonasal Removal of Juvenile Angiofibromas

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Abstract: Background. Juvenile nasal angiofibroma (JNA) is a very rare benign lesion originating from the pterygopalatine fossa with distinctive epidemiologic features and growth patterns. The typical patient is an adolescent male with a clinical history of recurrent severe nasal bleedings　and blockage the nose. Currently, even though surgery often caused severe operative bleeding, it is considered the ideal treatment for JNA. Refinement in preoperative embolization, which provides significant reduction of intraoperative bleeding. In spite of breakthrough of Endoscopic techniques which minimize the risk of residual disease, the search of new devises which can help to management of JNA is still continue in order to minimize the surgical complications. Laser methods as surgical treatment have been actively used in rhinology during the past decades. We purposed to summarize information about current lasers and their use in rhinology.

Aim. The purpose of the study is the literature review and to describe our experience of using new blue laser during JNA removal. Evaluation of advantages and disadvantages, determination of indications and limits of its use in rhinosurgery

Methods- A literature review from 2000 to 2022 using the PubMed database was employed. Keywords used included "laser surgery", "blue light laser", "photoangiolytic laser", "laser in rhinosurgery". The most up to date studies published for each rhinology condition that was treated with laser surgery was reviewed.

Then endoscopic removal through the nose was performed. During the surgery TrueBlue laser was used to cut the tissues and coagulate injured vessels.

Results. Rhinological conditions appropriate for laser applications are discussed. There are related papers to a number of applications including hereditary hemorrhagic telangiectasia, rhinitis, turbinate surgery, dacryocystorhinostomy, septoplasty, choanal atresia, and sphenopalatine artery ligation, paying attention to the outcomes of the studies.　It is the first experience of using blue laser in rhinosurgery and particulary ib removing JNA.

Conclusion. Intranasal laser surgery, despite the fact that interventions are performed almost bloodlessly, and often do not require nasal tamponade, indications for their performance are limited, due to deep burns of the nasal mucosa, and alteration of mucociliary clearance therefore lasers are not so often used in rhinology. The short-wave blue laser with a wavelength of 445 nm, used in Europe in oto- and laryngosurgery, may have some potential advantages in rhinosurgery, but the practical dataset are limited yet.

Keywords: angiofibroma, laser surgery, blue laser

1. Introduction

Juvenile nasal angiofibroma (JNA) is a benign vascular neoplasm which affects young males between 9 and 19 years of age and accounts for 0.05% of all head and neck tumors [1]. Glad and colleagues [2] reported an incidence of JA in Denmark of 0.4 cases per million inhabitants per year. In the Middle East and India, the incidence seems to be much higher than in Europe [3].

Surgical removal of JNA is method of choice of its treatment [4, 5] and is considered as one of the most difficult surgeries in otorhinolaryngology because it is very often   associated with profuse, streaming bleeding. Massive blood loss in advanced cases can be of 1 or 2 amounts of blood volume circulation, and often may need blood transfusion. Therefore it is actually to develop new methods of reducing operative blood loss. Laser methods of surgical treatment have been actively used in otorhinolaryngology in past years because of apparition of new lasers with advanced properties. The short-wave blue laser with a wavelength of 445 nm, is used in Europe in oto- and laryngosurgery, but was not used in rhinology [28]. The database is limited yet, but we suppose that it may have some potential advantages in rhinosurgery, and particularly in removal of JNA.

The purpose of this paper is to review the literature and to describe our first experience of using a new blue laser in juvenile angiofibroma surgery.

2. Patients and Methods

We treated surgical 7 patients with JNA stage 3-4 according to Snyderman classification and used blue laser at some stages of the intervention. All patients were male, 10-17 years old, mean age 13.8 years. All patients underwent superselective angiography and vascular embolization of juvenile angiofibroma preoperatively, followed by endoscopic endonasal tumor removal. Two of the patients were admitted with continued angiofibroma growth after surgical treatment with embolization in another hospital, while the remaining patients was primary diagnosed.

During surgery we used mono- and bipolar coagulators, vessel clipping and surgicelle hemostatic sponge. In addition, we used the WOLF TruBlue blue laser with a tissue penetration depth of 445 nm. TruBlue is the smallest laser system for coagulation, vaporization and bloodless surgery, combined in an extremely flexible fiber. It is a diode laser, with a penetration depth of 0.1 mm. TruBlue combines the advantages of the CO2 laser with those of the KTP laser [6].

3. Results

The average blood loss during surgery was 150 (50; 350) ml; there were no surgical complications. There were minimal reactive changes in the nose. All patients were discharged on the 2nd or 3rd day after the surgery.

The particularity of laser exposure was the possibility of coagulation and tissue cutting even in conditions of heavy bleeding (fig. 1) and minimal burns of the surrounding tissues after laser exposure(fig. 2, fig. 3, fig. 4)
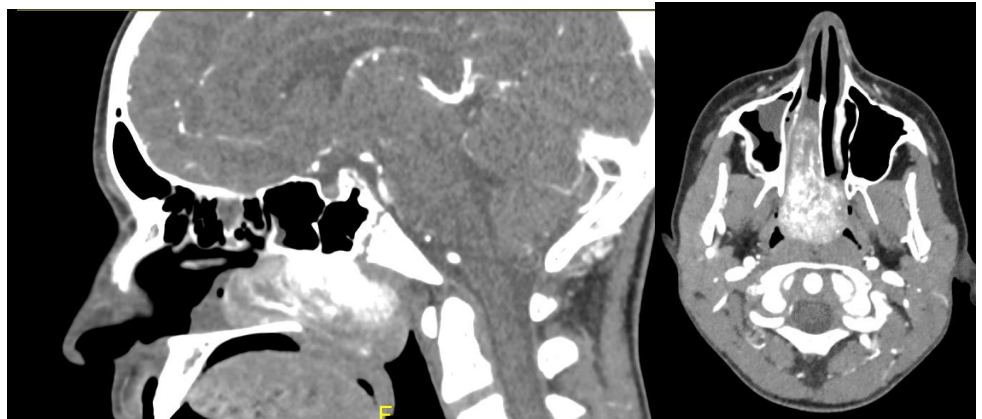
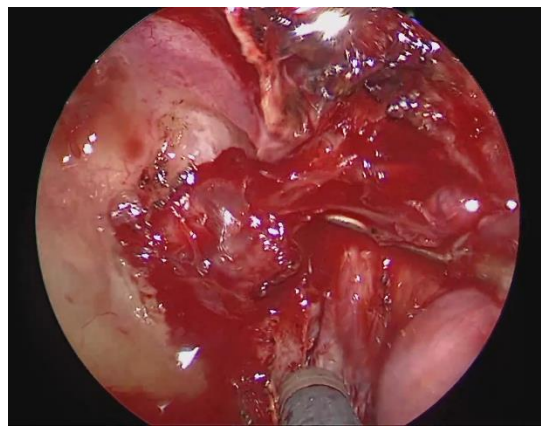**Figure 1.** CT image of a patient with angiofibroma

Figure 2. Endoscopic view during the surgery: posterior wall of the maxillary sinus had removed, JNA, in pterigopalatine fossa (shown in white arrow), the place of its origine was removed.
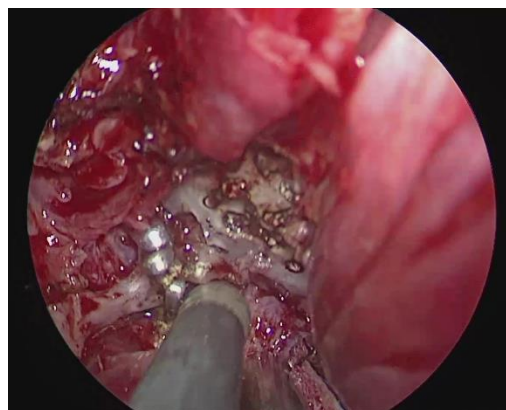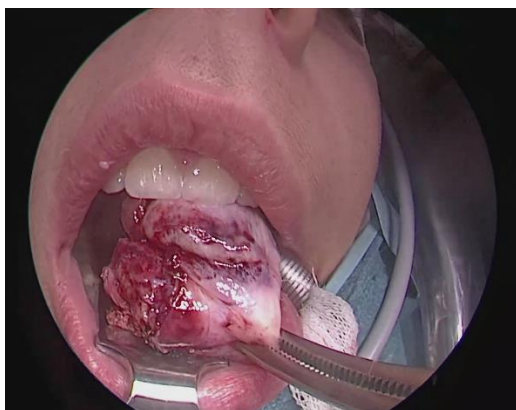

Figure 3. The same endoscopic view after endooscopic displacement of JNA down into nasopharynx. The maxillary artery was clipped. The place of blue laser exposure (shown in white arrow). There is seen no bleeding, minimal trauma of mucosa.

Figure 4. The step of transoral removal of juvenile angiofibroma. There is no bleeding, and minmal trauma without submucosal necrosis of big stage 3 JA by Karl Snyderman classification.

4. Discussion

JNA is a rare lesion, which affects male adolescents and frequently regresses only after full development of secondary sex characteristics. This fact provided the evidence of hormonal influence on JNA growth [7]. Hormonal pathogenesis of this lesion is still a matter of debate, in spite of several reports of presence of androgen and / or estrogen receptors and their role in the tumor development or regression [8-10].

Although several nonsurgical methods have been proposed, surgery is unanimously considered the treatment of choice for JNA. In the last two decades, the surgical approach to the lesion has considerably evolved mainly in relation to the indication of endoscopic techniques. Transpalatal, transpharyngeal, transfacial through lateral rhinotomy, midfacial degloving, and Le Fort I osteotomy, other than infratemporal and subtemporal lateral approaches [11, 12, 13] were once the traditional surgical methods commonly performed to remove JNA. Advances in radiological imaging and improvements of embolization techniques have significantly contributed to better preoperative management and treatment planning. Moreover, increasing experience in endoscopic surgery together with better understanding sinonasal anatomy, provide the possibility to create approach through the nose such to the orbit, infratemporal fossa, masticatory space, parasellar region, furthermore the using intraoperative navigation, and the well-known morbidity associated with external procedures have made an endoscopic approach as preferable in JNA management. Due to the fact that one of the most challenging aspects in JNA surgery is control of intraoperative bleeding, the cooperation anesthesiologists with endoscopic skull base surgeons, the using blood saving methods, in particularly cell saver [14], and hemostatic materials help the surgeon to control bleeding [15].

The first surgical step to create endoscopic approach is to expose JNA as extensively as possible by middle turbinectomy, ethmoidectomy, wide antrostomy and sphenoidotomy [16]. Resection of the posterior third of the nasal septum can also enhances the exposure of the nasopharyngeal portion of the lesion. The posterior wall of the maxillary sinus has to be resected laterally as much as lateral as the lesion spreading into the pterygopalatine and/or infratemporal fossae. For JNA which involving far into infratemporal fossa, lateral exposure through a so-called Sturmann-Canfield maxillectomy can be used. All these provides possibility to   make a resection of the le-

sion from anteromedial corner of the maxillary sinus [17]. An endoscopically assisted antral window approach through the anterior wall of the maxillary sinus, as proposed by Pasquini et al. [18], may be considered a possible alternative. Another important principle in the resection of large-volume lesions is the fragmentation technique ("piece-meal" resection) that helps to completely assess the extension without an increased risk of recurrence [19]. During dissection, to maintain a proper cleavage plain between the tumor and adjacent tissues, a four-handed technique is highly recommended [20]. The procedure is completed by accurate subperiosteal dissection of the tumor attachment and subsequent extensive drilling of the basisphenoid and other bone area where the JA is adhered to remove residual disease, which may not be immediately evident, and prevent its regrowth [21].

Because of its high degree of vascularization, bleeding during surgery is a crucial topic. Some studies compared the blood loss between endoscopic and external approaches, showing a lower loss in endoscopic surgery [21, 22]. However, the reliability of these data requires confirmation since JNA treated by an open approach usually have a higher stage than those resected endoscopically. Another question widely discussed in literature is the reduction of intraoperative bleeding, thanks to preoperative embolization. Some authors have correlated the amount of blood loss with the quality of embolization and with tumor extension [23, 24]. Glad et al. [25] showed a statistically significant decrease in bleeding between the nonembolized (650 mL) and the embolized group (1200 mL).

To better control bleeding during the procedure, several authors have proposed the use of diode laser, KTP laser, or ultrasonic scalpel [20; 27].

Although surgical lasers were introduced more than 30 years ago, their use and popularity in nasal and sinus disease have been limited. Even so, there are many practitioners who find the laser a valuable surgical tool for nasal and sinus disease, either alone or in combination with other treatment modalities. The range of surgical interventions in ENT practice covers both tissues with abundant blood supply, where the hemostatic properties of the laser should be fully realized, and areas requiring the most delicate approach, where any excessive thermal damage may lead to scarring (vocal folds) [29]. Laser sinus surgery is limited by the inability of most lasers to ablate bone [30]. The common types of lasers that used in the subspecialty of rhinology include argon (Ar), potassium titanyl phosphate (KTP), diode, neodymium-doped yttrium aluminum garnet (Nd: YAG), holmium-doped yttrium aluminum garnet (Ho: YAG), and the most popular carbon dioxide (CO_2). Each laser type has different properties for cutting, coagulation, and evaporating of tissues [31]. The ideal laser for rhinology needs to efficiently ablate dense bone, remove soft tissue, and coagulate a dense vascular bed.

The average amount of blood loss during the surgery of advanced stages of JNA is usually 1500-2000 ml. The blood loss in described cases was about 150 ml. There were complications occurred.

The blue light laser combines the photoangiolytic properties of KTP and cutting properties of CO_2 lasers. It is equipped with a more flexible, versatile energy conductor - a standard fiber light guide with a diameter of 0.3 to 0.6 mm. Impulse and constant exposure modes could be used [3].

A feature of the laser effect was the minimal burn of the surrounding tissues, the possibility of coagulation and tissue cutting even in conditions of heavy bleeding. This characteristic made the blue laser made it suitable in treatment of hereditary hemorrhagic telangiectasia (HHT) that is accompanied with recurrent nasal bleeding. Very precise coagulation of the vessels without affecting the surrounding tissue and superficial penetration into the tissue has great advantages for patients with HHT, the impact of which can lead to complications in the long term [32].

There is a potential shorter period or recovery after using blue laser because in one experimental study, where an in vitro cell culture model was created to evaluate the effects of a 445 nm diode laser compared to an infrared (IR) diode laser. The blue laser system showed faster wound healing compared to the IR laser [28].

During the surgery we used the Wolf TruBlue Blue Laser at a number of steps, which made it possible to control bleeding from the branches of the sphenopalatine, posterior ethmoidal and septal arteries well.

Intranasal laser surgery, despite the fact that interventions are performed almost bloodlessly, and often do not require nasal packing, indications for its usage are limited, due to deep burning of the nasal mucosa, and alteration of mucociliary clearance therefore lasers are not so often used in rhinology

These surgeries should be done in big specialized centers with all necessary equipment and professional team. Nevertheless, there is no consensus in the literature about its expediently using because of complications, which may occur. It is very important meticulous hemostasis during endoscopic removal juvenile angiofibroma because of deep localization of the tumor and to been able to do surgery in a narrow hole under endoscopic control for to put endoscope closure to the operative field and injured vessels to avoid severe complications.

5. Conclusions

There was first experience of usages of TrueBlue laser during endoscopic endonasal surgery in the world and the first experience of its use during endoscopic removal of the tumor. It is less traumatic and with good possibility to control intraoperative bleeding with very good with wound healing.

TrueBlue laser is good devise in experienced hands. The indications, contraindications were discussed. Further investigations of usage TrueBlue laser should be done. Evaluation of advantages and disadvantages, determination of indications and limits of its use in rhinosurgery.

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