



## The use of CO<sub>2</sub> laser in laryngeal cancer surgery

### Zastosowanie lasera CO<sub>2</sub> w leczeniu raka krtani

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#### ABSTRACT

Lasers have now become a common tool used in human lives. They have found their application in numerous, unrelated disciplines. Implemented commonly in medicine, in laryngological practice it has become a tool used primarily in endoscopic laryngeal microsurgery.

The CO<sub>2</sub> laser is most commonly used in laryngeal microsurgery. In some cases the outcome of laser therapies is comparable to that achieved by means of traditional procedures – partial surgery through laryngofissure and radiotherapy. As a proved non-invasive method with a small number of complications, it has become elective surgery in stages T1 and T2 of laryngeal cancer. The benefits effecting from the use of a CO<sub>2</sub> laser also include shorter hospitalization, quicker recovery, lower costs and no need for a tracheotomy or feeding tube. Such a method is far better accepted by the patients, which contributes to an improved mental condition and healing.

If unsuccessful, the therapy may be combined with radiotherapy or external access surgery with a well-preserved anatomy.

#### KEY WORDS

endoscopic surgery, CO<sub>2</sub> laser, laryngeal surgery

#### STRESZCZENIE

Laser na stałe wkomponował się w życie człowieka. Jest urządzeniem, które znajduje zastosowanie w wielu niespokrewnionych ze sobą dziedzinach. Używany powszechnie w medycynie, w laryngologii stał się narzędziem stosowanym przede wszystkim w mikrochirurgii krtani z dostępu endoskopowego. Do mikrochirurgii laserowej krtani używany jest najczęściej laser CO<sub>2</sub>. W wybranych przypadkach skuteczność leczenia laserem jest porównywalna z tradycyjnymi metodami, m.in. operacją częściową z dostępu przez laryngofissurę oraz radioterapią. Będąc metodą małoinwazyjną,

Received: 22.01.2018

Revised: 08.02.2018

Accepted: 13.02.2018

Published online: 08.05.2018

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dającą małą liczbę powikłań, stał się techniką z wyboru w leczeniu raka krtani w stopniu zaawansowania miejscowego T1 i T2. Ponadto wśród zalet stosowania lasera CO<sub>2</sub> w leczeniu należy wymienić krótszy czas hospitalizacji i rekonwalescencji, niższy koszt, brak konieczności założenia tracheotomii i żywienia przez sondę dożołądkową. Metoda ta jest zdecydowanie lepiej akceptowana przez pacjentów, co pozytywnie wpływa na ich kondycję psychiczną i proces gojenia. W razie niepowodzenia leczenie może zostać uzupełnione o radioterapię czy też chirurgię z dojścia zewnętrznego, przy dość dobrze zachowanej anatomii.

#### KEY WORDS

laser CO<sub>2</sub>, chirurgia krtani, chirurgia endoskopowa

#### ARTICLE

The laser has now become a common element of human lives. Its wide scope of applications comprise numerous unrelated disciplines, as it has found its use in industry, land survey, civil engineering, military technologies, telecommunication and medicine. The design of a laser incorporates an active medium, optical resonator and a pumping system. The great number of materials used to engineer laser components allows the construction of devices dedicated to extremely different applications, sizes and performances [1]. The numerous applications of lasers throughout their relatively short history prove the importance of this invention. In 1964 the Nobel Prize in physics was awarded to N.G. Basov and A.M. Prokhorov from the USSR and C.H. Townes from the USA, whose studies established the background for laser operation [2]. The first laser worldwide was launched in 1960 and it was the ruby laser design. The first Polish laser was built soon after, in 1963, in the Military University of Technology [3]. The first medical use of a laser was that by Leo Goldman, a dermatologist who applied a ruby laser in 1962 [4]. In Poland, the pioneer in laser laryngeal surgery was Professor Janczewski; in 1972, together with M.S Strong, they published their first report on the use of the CO<sub>2</sub> laser in laryngeal conditions [5]. The surgical laser is a high-energy unit with a power range between 1 and 20 W; such lasers are used by laryngological operators. A low-energy laser is used in physiotherapy to stimulate tissue regeneration and healing, while mediumpower lasers have been dedicated to diagnostics and photodynamic therapies [6]. The advantages of lasers which have definitely strengthened their position in medicine are the capabilities of spot application and precise dosage. Moreover, the power is selected individually to meet the specific needs of a given condition and patient, so it is a nearly "tailored" tool. The remote application the laser offers has made it an indispensable tool in endoscopic laryngeal surgery. A classical tool in laryngeal endoscopy is now the Kleinsasser set, incorporating a rigid tube which is inserted to the level of

the vocal folds through the patient's open mouth and then is fixed. Before lasers were implemented, laryngeal procedures had been performed by means of microsurgical instruments. Such methods are still in use, however, to perform precise laryngeal surgery, it demands both extreme precision and skills of the surgeon. Therefore, given the anatomical position of the larynx and the possible access, a laser appears to be a perfect tool in surgeries of lesions restricted to the larynx, comprising the laryngeal mucosa as well as its ligaments, muscles and cartilages. Furthermore, thanks to the effect of high temperature the risk of haemorrhage is remarkably reduced. The laser offers numerous opportunities in laryngeal surgery. They include the treatment of benign lesions, such as polyps and papillomas as well as therapies in malignant tumours. In addition, it may be used in treating injuries and some iatrogenic effects, e.g. bilateral vocal cord paralysis (BVCP), accretions or laryngeal web. Complications following laser therapies are rare and the reported ones include oedemas, inflammatory conditions, bleeding and dyspnoea. Adhesion or granulation may appear later, frequently demanding reoperation [7]. The outcome of laser laryngeal surgery in T1 and T2 tumours and sometimes also T3 is comparable to surgeries from external access through laryngofissure, combined with radiotherapy. Most often, the lesions are located in the middle laryngeal cavity, showing usually well differentiated G1, GII grades. The second in incidence is the epiglottal region, characteristically showing GIII tumours with poor differentiation [8]. Laser laryngeal surgery has been studied by numerous authors, evaluating its efficacy as compared to other therapies, and also showing even more extensive opportunities for tissue resection and ablation. In their retrospective study comprising a heterogenous group of patients, Wan et al. evaluated the complications following laryngeal surgeries carried out using a CO<sub>2</sub> laser. They studied the course of therapies in 500 patients operated on for benign and malignant tumours, showing the rate of complications reaching 10.2% which occurred mostly in patients diagnosed with cancer (26.9% vs 5.8%). This was basically due to the greater extent of the surgery. Following the classification proposed by Vilaseca-Gonzales [9], Wan distin-



guishes among minor complications which may be treated best at ENT outpatient clinics and result in no consequences, and major ones which may threaten the patient's life and health and therefore must be managed in hospital conditions. Major complications were observed in 4 patients (0.8% of the test group) and were as follows: postoperative bleeding, postoperative dyspnoea, midoperative airway inflammation and adhesion. All the patients presenting complications were diagnosed with laryngeal cancer [7].

Lachowska compared the oncological outcome of glottal cancer therapy through conventional chordectomy from external access and the procedure by means of endoscopic laser surgery. The study comprised 73 patients with stage Tis and T1N0M0 glottal cancer. 21 underwent traditional surgery while 52 were operated by laser. The author observed that the outcome of both therapies was very similar and the actual efficacy of the procedure does not depend on the extent of the lesion before operation. In the case of patients operated by means of laryngofissure, the hospitalization time was extended to 8.1 days while those undergoing laser therapies stayed at hospital for approximately 2.8 days. The difference is statistically significant [10]. A similar evaluation was carried out by Namysłowski, Campora, Mendelsohn, who obtained corresponding results [11,12,13]. The literature available points to the fact that all the authors report on cases managed from external access before a laser was actually purchased or during break-down of the unit. This proves that laser surgery may successfully replace conventional procedures in the laryngeal region in most low or medium staged lesions (T stage). The outcomes of laser therapy and radiotherapy are also similar in low stage local tumours, T1 and T2. Evaluating 351 patients with T1a laryngeal cancer, Mahler et al. Observed no differences in the 5-year survival in either group. Upon relapse, a total laryngectomy was performed more often in the patients who underwent radiotherapy, therefore the authors recommend laser surgery for patients with that local stage of tumour [14]. Cömert et al. analysed T1 and T2 patients with infiltrated or not infiltrated anterior commissure. The authors showed no advantage of any of the methods when relating to 3-year survival in the evaluated groups. [15]. Similar conclusions were drawn by Warner and O'Hara, who reviewed 48 publications in the treatment of patients with T2 tumours and 36 reporting on individuals with T1 lesions [16,17].

Regardless of the selected method, a patient has to subscribe informed consent to a tracheotomy. He also has to be informed about probable worsening of the voice, effecting from each of the described interventions. In order to ensure oncological purity, removal of the lesion within the borders of the healthy tissue is needed. In such a case, tumour purity is more important than preserving normal voice function. A partial

laryngectomy and radiotherapy allow physiological phonation at different degrees of the condition. Remelts et al. present comparable results for the treatment of glottal cancer with radiotherapy and with a CO<sub>2</sub> laser in the context of oncological purity and quality of phonation in T1a tumours. Due to more extensive removal of glottal tissues with the CO<sub>2</sub> laser, the voice function was worse than in patients after radiotherapy. The quoted study comprised a group of 259 patients [18]. Aaltonen et al. also evaluated voice changes following glottal cancer therapies. They observed a wider true glottis and blowing voice in patients after laser surgery. Taking into consideration similar outcomes of the treatment, patients who particularly value their vocal quality are recommended to undergo radiotherapy [19]. The key role is that of proper qualification for the surgery. At present, laser laryngeal surgery is elective therapy in low stage cases [13]. The indications for external access surgery are: poor anatomical conditions preventing visualization of the larynx in direct laryngoscopy, relapse after radiotherapy administered within the "salvage surgery" regimen, as well as some cases of local T3 stage lesions where application of the laser could be non-radical surgery [20]. Infiltration of the anterior commissure or the vocal process may be a serious obstacle, however, it is not a contraindication for endoscopic laryngeal surgery. Taking into consideration the thin barrier formed by the thyroid cartilage with no internal perichondrium, infiltration of the anterior commissure is a poor prognostic factor. Therefore, any surgeries performed in this region demand particular vigilance. Balica et al. carried out a 10-year evaluation of patients with laryngeal cancer, where the tumour affected both vocal folds and the anterior commissure at stages T1b, T2 and T3. In 55 of 127 patients, a partial operation was performed using a CO<sub>2</sub> laser. The remaining patients underwent a total laryngectomy, frontolateral laryngectomy and radiotherapy. The patients showed no metastasis to local lymph nodes, infiltration of the arytenoid cartilage as well as normal or impaired mobility of the vocal folds. The authors pointed to the high efficacy of such therapies, emphasizing no recurrence in 50% (91%) during a one-year follow up. No major postoperative complications were noted, none of the patients required a tracheotomy and one half of the patients declared that the quality of their voice was good [21]. Similar observations were made by Blanch et al., who evaluated 241 patients with T2–T3 cancer infiltrating the anterior commissure and treated with a CO<sub>2</sub> laser. The 5-year survival rate in patients with the negative margin status was 83.6% [22]. On the other hand, Olszewski demonstrated that a 5-year survival rate for patients in whom the scope of the surgery was extended to comprise the anterior commissure or the arytenoid cartilage, was low and



did not exceed 50% [23]. Similar results were reported by other authors [24,25]. A separate group of patients includes individuals with upper laryngeal tumours. As indicated earlier, they are lesions of low differentiation, higher dynamics and frequency of local lymph node metastasis. Delgado et al. observed in patients the outcome of therapies of the upper larynx. They evaluated 53 patients, most of whom were diagnosed with epiglottal cancer (73.6%), stages T1-T3. All the patients were treated with a CO<sub>2</sub> laser, moreover 88.7% underwent lymphatic surgery, including the bilateral procedure in 56.6%. Due to a relapse, a total laryngectomy had to be performed in 9.43 of the patients. 5-year survival was achieved in 65% of the patients. Distant metastasis, mostly to the lungs, was observed in 9.8%. The authors also indicated a high rate of complications, however, most of them were associated with lymphatic surgery. In addition, a tracheotomy had to be performed in 12 patients during the preoperative period. 20.7% of patients developed pneumonia. Two patients died during the preoperative period – of a massive haemorrhage and pneumonia complicated with multiple organ failure [26]. A corresponding analysis was carried out by Peretti et al. who pointed to a 5-year survival specific for 84.4% of the patients [27].

Evaluation of the presented methods should emphasize the major role of appropriate selection of the surgery, taking into consideration the tumour location, TNM grade, the patient's age, any concomitant diseases and the general health condition. Before treatment, it is essential to talk to the patient and inform him appropriately about the opportunities and effects of the therapy. A patient who is aware of his condition and thoroughly informed about the planned regimen and its consequences will easier bear the recovery period which contributes remarkably to the healing process as well as cooperation with the medical personnel and relations with the patient's family.

To sum up, laser surgery has now become an elective method in managing T1 and T2 tumours as well as some selected T3 cancers. Regional lymphatic metastasis is no contraindication to laser therapy, which in such a case should be extended to include lymphatic surgery or radiotherapy. Endoscopic surgery by means of a CO<sub>2</sub> laser is much shorter than external access procedures, which is particularly important for the patients. The operational field is restricted to the larynx interior, therefore a patient is not vulnerable to breached continuity of the integuments and related complications. The patient's comfort throughout the postoperative period is improved as applying a feeding tube is not needed. Usually there no need to perform a tracheotomy during the perioperative period. Laser surgery offers shorter hospitalization, which contributes to the patient's well-being and lower costs of the therapy. The patient recovers much quicker and normal social voice function is restored.

As a tool in laryngeal cancer therapies, the CO<sub>2</sub> laser does not exclude the use of radiotherapy or radical surgery should primary treatment prove unsuccessful or in the case of local recurrence.

Standalone radiotherapy has been equally efficient in managing T1 and T2 laryngeal cancer, however, the long-term treatment it requires brings effects the patient experiences long after discontinuation. They are mainly mucous membrane dryness, burns, tissue oedema and impaired general immunity. The treated tissues are exposed to irreversible changes which may prejudice the outcome of potential surgery in recurrence of the neoplastic process or unsuccessful treatment.

The CO<sub>2</sub> laser is an efficient and comfortable tool used in managing some selected cases of laryngeal cancer and should therefore be currently implemented at head and neck surgical centres.

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