Application of endoscopic CO2 laser surgery for benign lesions and early malignant tumours of the larynx

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Laser

- LASER - Light Amplification by Stimulated Emission of Radiation
- Low energy laser: soft laser
- High energy laser
- Cut, coagulation laser
- Impuls, continuous mode
Human application of lasers

- **Gas lasers**: CO2 10.6 μm – larynx, pharynx, trachea, nose, ear, He-Neon (soft laser),
- **Ion lasers**: Argon 350-530 nm, Krypton 400-610 nm - dermatology
- **Diode laser**: 808 nm
- **Dye laser**: different wavelength
- **Excimer laser**: - ear
- **Neodym YAG**: 1064nm, Neodym doped - Yttrium-Aluminium-Granat-Laser, fiberoptic – trachea, brochi
- **Combi laser**: Nd:YAG+CO2 – pharynx trachea, brochi
- **KTP laser**: 532 nm - Potassium Titanyl Phosphate — nose
Specification of CO2 laser

- **CO2 laser - wavelength:** 10.6 μm
- Cutting laser, up to 0.5 mm diameter of vessel coagulation
- High energy, 60-100 W
- 0.25-0.80 mm spot – burning tissue
- Straight spread of laser beam (flexible optic also available)
- Coupled with microscope easy and exact manipulation
CO2 Laser applications for the larynx:

Endoscopic (transoral) surgical intervention:

- Benign lesions
- Early malignant tumours of the larynx (hypopharynx)
Method

- Preoperative investigation: Endoscopy of the larynx, sonography and CT scan of the neck (MRI)
- **Instruments:** TLS 61 Tungsram laser and later Lasram, Daeshin laser surgical devices
- Opton, Leica microscope
- Kleinsasser and **Weerda** laryngoscope, laryngomicroscopic surgical instruments
- ITN (intratracheal narcosis), JET
Laryngomicroscopy and laser resection in ITN or JET narcosis
Laryngomicroscopy, intact vocal folds, polyp
Benign lesions of the larynx, indications – laser treatment

- Polyp
- Cyst
- Nodule
- Reinke oedema
- Laryngitis chronic (hyperplastic)
- Laryngocele
- Granuloma
- Contact ulcus
- Papilloma
- Benign lesions (tumours): hemangioma, chondroma, leiomyoma, fibroma
- Praecancerosis
- Oedema
- Tonsil, lingual hypertrophy
- Stenosis, laryngotracheal
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<tr>
<td>Polyp, cysta, nodulus, cicatrix, granuloma, Reinke edema, chr. laryngitis (hyperplastic), laryngocele, contact ulcer</td>
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<td>Papilloma laryngis</td>
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<td>Hemangioma</td>
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<td>Laser arytenoidectomy</td>
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<td>-</td>
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<tr>
<td>Lingual tonsil hypertrophy</td>
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Polyp of the vocal cord
Polyp, vocal cord

- Symptoms: dysphonia, hoarsness, unilateral
- Etiology: more frequently in male
- Pathogenesis: recurrent inflammations, hyperkinetic disorders and chronic irritation
- Types: peduncular and „wide” seated
- Therapy: laryngomicroscopy - removal with cold instrument (or laser)
Polyp, laryngomicroscopy, excision
Cyst
Nodule of the vocal cords
Nodule, laryngeal

- Symptoms: hoarsness, bilateral lesion
- Pathogenesis: abuse of vocal folds - chronic irritation
- Singer’s nodule, aerobic trainers, teachers, smokers
- Therapy: conservative – laryngeal diet, phoniatic treatment, in advanced case laryngomicroscopy – removal (laser)
Reinke’s edema
Reinke’s edema

• Symptoms: hoarsness, dysphonia, diplophonia, in extreme size - stridor

• Pathogenesis: in the Reinke’s space edema, vocal fold abuse, smoker women

• Therapy: laryngeal diet, laryngomicroscopy – suction of the edema (incision), in severe case decortication of the vocal cord, (laser excision)
Chronic laryngitis, leukoplakia
Chronic laryngitis

- Symptoms: hoarsness
- Pathogenesis: chr. irritation, smokers, chemical drugs, dust, environmental
- Therapy: laryngeal diet, vitamin A, hyperplastic laryngitis: laryngomicroscopy – decortication, laser
Laryngoele

- Internal laryngoele (Morgagni-ventricule)
- External laryngoele
- Symptom: stridor, inspiratoric
- Therapy: endolaryngeal laser, external approach surgery
Laryngeal cyst - CO2 laser excision
Pediatric laryngeal diseases

- Cyst
- Granuloma
- Hemangioma laryngis
- Laryngocoele
- Developmental disorders – stenosis (web)
Hemangioma laryngis
endoscopic laser excision
Laryngocele
Laryngocele
endoscopic laser excision
Postintubation granuloma
Granuloma laryngis, contact ulcer

- Symptoms: hoarsness, stridor
- Pathogenesis: postintubation (some weeks later), chronic irritation
- Therapy: laryngomicroscopy – removal with „cold instrument„, or laser
Laryngeal papilloma
Laryngeal papillomas

- Symptoms: hoarsness, dyspnoe
- Pathogenesis: human papilloma virus (6,11 juvenile types, 16,18 adult types)
- Therapy: laryngomicroscopy CO2 laser, antiviral drugs, vaccination (Silgard)
Laryngeal papillomas: standard indication - endolaryngeal laser surgery
Laryngeal papilloma, CO2 laser excision, vaporization
Leiomyoma
Praecancerosis
Praecancerosis

- Symptom: hoarsness
- Pathogenesis: Dysplasia I-II-III. types, smoking, chr. irritation
- Therapy: laryngomicroscopy – decortication, laser excision
Malignant tumours of the larynx: Localization, distribution and prognosis

- Glottic tumours – vocal fold (about 48%)
- Supraglottic tumours (about 50%)
- Subglottic tumours (1-2%)
Carcinoma of the larynx
Carcinoma planocellulare laryngis

Prevalence of the laryngeal tumour: 5.- 6. most frequent of the malignancies in adults.

Predisposition:

- Inherited genetic conditions (inherited, acquired, DNA mutation)
- Incidence in countries (continents)
- Habits: smoking - tobacco use (abuse)!!, alcohol consumption (lesion of the liver), chemicals, feeding, hygiene of the mouth
- Profession, pollution.
- Appearance: age of 50-70 years, Men-women ratio: 20:1 (USA: 5:1)
Pathogenesis

- Invasive carcinoma may develop from dysplasia and transforms to cancer (in situ)
- Precancerosis: Keratosis without atypia, Keratosis with atypia (I-III.), Cc. in situ
- Dysplasia I.- dysplasia II.- dysplasia III = in situ carcinoma
- More than 92% of laryngeal carcinoma: established as a squamous cell carcinoma
- Minority of the laryngeal malignant epithelial tumours: verrucous carcinoma, adenocarcinoma, basal cell carcinoma, carcinosarcoma
- Sarcoma is extremly rare: fibro-, myo-, chondrosarcoma, rhabdomyosarcoma
Prognosis of the laryngeal cancer depends on:

- Localization (supraglottic, glottic, subglottic site)
- Staging, TNM classification
- Differentiation of the tumour
- Metastasis formation
TNM classification

- Laryngeal cancers are staged and classified according to the TNM system as explained in the latest manual of the ICD-O (International Classification of Diseases for Oncology) WHO, TNM Classification for Malignant Tumours – UICC and American Joint Commission on Cancer. There is a separate staging system for cancers that affect different subdivisions of the larynx. Subglottic cancer is quite rare and so we focus on cancers affecting the glottic and supraglottic larynx.
- Clinical evaluation: cTNM, pathological finding: pTNM
- Hungarian issue for laryngeal tumour classification: A gége- és hypopharynx-laphámrák osztályozása, kivizsgálása és kezelési javaslata Magyar Onkológia, 46, 4, 301-305, 2002
Diagnostic in laryngeal neck tumours

• Case history: personal, familiar, social questionnaire, feeding
• Clinical examination: indirect - and direct laryngoscopy, endoscopy, palpation of the neck (metastasis)
• Pathology (primary tumour - biopsy, metastasis - fine needle aspiration)
• Imaging (CT, MRI, sonography of the neck, chest X-ray, sonography of the belly)
• Staging
• Research:
  • Examination of DNA (PCR), gen chips
  • Investigation of immun cells
  • Tumour markers
Symptoms, clinical patterns

- Vocal cord cancer: hoarseness
- Supraglottic cancer: dysphagia, referred pain in the ear - otalgia irradiata (supplied by n. vagus), dyspnoe, hoarseness
- Subglottic cancer: voice disorder, dyspnoe
Diagnostic, evaluation, therapy: endoscopy of the larynx

Indirect laryngoscopy

Direct laryngoscopy:
Rigid endoscopy - diagnostic
Flexible endoscopy - diagnostic
Laryngomicroscopy – diagnostic and therapy

Laryngostroboscopy - phonation
Photodynamic endoscopy - oncology
Contact endoscopy - oncology, etc.
Endoscopy of the larynx with 70º rigid optic and fiberscopy visualizing the larynx

Video-endoscopy: tumour of the vocal fold, outpatient
Direct laryngoscopy: laryngomicroscopy – general anaesthesia (ITN) or JET narcosis

Application of microscope and rigid, long optic for the preop. diagnostic

Laryngomicroscopy
Method

- Preoperative investigations: Endoscopy of the larynx, sonography and CT scan of the neck (MRI)
- Instruments: TLS 61 Tungsram laser, Lasram and later Daeshin DS 40UB laser surgical devices
- Opton, Leica microscopes
- Kleinsasser and Weerda laryngoscopes
- Laryngomicroscopic instruments
- General anaesthesia (intratracheal narcosis)
Basic treatment options for early laryngeal carcinoma

• **Surgery**
• Radiation therapy
• Chemotherapy
• Combined treatments
• **By Onco-Team board consultation, decision!**
Treatment options of early (T1, T2) malignancies of the larynx - Surgery

• Surgical interventions: transoral (endoscopic) versus open approach surgery/radiation therapy

• *Goals to achieve:*

• 1. Good oncological result
• 2. Functional results: preserving the laryngeal functions (vocal cord), acceptable voice, swallowing without feeding tube and trachea-canule
• 3. Aesthetic results: no tracheostomy, no scar on the neck (endoscopic surgery)
• 4. Cost-benefit relations
Early glottic cancer: endoscopic CO2 laser surgery was introduced at our department in 1987 by professor Czigner.

- T1a, T1 b, (T2) glottic carcinoma - laser cordectomy


-Supraglottic and marginal laryngeal tumours (T1, T2)


Patient’s material, method

• 375 laser cordectomy was performed (324 patients), in patients with Tis-T2 vocal cord cancer between 1987 and 2011.
• 289 patients with a minimum of 5 years follow up were analysed.
• Preoperative investigations: Endoscopy of the larynx, sonography and CT scan of the neck (MRI)
• Laryngomicroscopy: Tungsram TLS61, Lasram laser and Daeshin – DS 40UB laser devices, Opton microscope, Kleinsasser and Weerda laryngoscopes, rigid optics
• Laser cordectomies were divided after the ELS classification into 6 types
• The resected specimen was sent oriented and marked for pathological examination
Cancer of the vocal fold - 289 patients

- Ratio - Male : Female = 5:1 (USA)
- At the Dept. ORL-HNS Szeged: male (87%) : female (13%) ratio = 7.5:1

Age: 40-70 years - 81%

Predisposing factors
- smoking ± alcohol consumption (75%)
- alcohol (4%)
- no reported (21%)
- Other etiology (gas, chemicals, dust – profession, irritation)
Risk factor analysis: smoking and alcohol in a case-control study (odds ratio-OR)

**SMOKING**

- **Case Group**: 22%
- **Control Group**: 26%

**ALCOHOL**

- **Case Group**: 48%
- **Control Group**: 25%

**OR** for smoking = \(\frac{78 \times 74}{22 \times 26} = 10\)
- 10x RISK

**OR** for alcohol = \(\frac{48 \times 75}{52 \times 25} = 2.7\)
- 2.7x RISK
T classification of early vocal cord cancers – 289 patients underwent transoral laser surgery

- Tis - 21 patients
- T1a - 179 patients
- T1b - 57 patients
- T2 - 32 patients

Laser device:
- Daeshin – DS 40UB
- Microspot
- Ultra pulse mode
6 types of laser cordectomy in our patient’s material (%)
(ELS classification)

I. Subepithelial excision - 16%
II. Subligamental excision
III. Intramuscular excision - 34% (type II., III.)
IV. Total cordectomy - 38%

V. a, Extension: anterior commissure
V. b, Extension: arytenoid (vocal process)
V. c, Extension: subglottis
V. d, Extension: ventricle (Morgagni sac)
VI. Anterior commissure - 12%

Eur Arch Otorhinolaryngol (2000) 257, 227-310
Endoscopic cordectomy, proposal for a classification by the Working Committee (ELS)
T1a vocal cord tumour (ALA), laser cordectomy, type II.
Vocal cord tumour T1a, type I. Laser cordectomy (ALA)
T2 vocal cord tumour, type V. laser cordectomy (ALA)
T1 vocal cord cancer
laser cordectomy (video)
Pathological establishment of T1, T2 vocal cord cancers after laser cordectomy

Squamous cell cancer - cc. planocellulare (96%)
cc. verrucosum (3%)
cc. mucoepidermoid (1%)
Surgery of the early glottic cancer 1987–2003: open approach, vertical partial laryngectomy was replaced by transoral (endoscopic) laser surgery
Results

- 289 laser cordectomy: 5 years survival: Tis tumours 100%, T1a 92%, T1b 77% and T2 83%
- For 87% of our patients with early glottic cancer CO2 laser excision proved to be a successful treatment, as a primary endoscopic surgery
- Types of laser cordectomy: I. type - 16%, II.-III. type - 34%, IV. type - 38%, V. type - 12%
Results after salvage therapy - laser cordectomy

Survival after salvage therapy: 97%.

In 96% of our patients larynx and voice have been preserved:
- 5 years laser specific survival: 93%

Salvage therapies (13%):
- Repeated laser resection 6%
- Hemilaryngectomy 3%
- Laryngectomy 3%
- Radiation therapy, fronto-lat. resection 1%
- Neck management: RND 3%
Functional results
subjective voice analysis

- Voice Handicap Index (n=23)
Functional results
Objective voice analysis with programme Praat

- **Jitter (%):**
  - II (n=2) vs III (n=9) vs IV (n=4) vs V (n=9) vs VI (n=1)

- **Schimmer (%):**
  - II (n=2) vs III (n=9) vs IV (n=4) vs V (n=9) vs VI (n=1)

- **Mean Phonation Time (s):**
  - II (n=2) vs III (n=9) vs IV (n=4) vs V (n=9) vs VI (n=1)
Cost benefit: transoral laser resection of tumours of the vocal cord

- Time of endoscopic surgical resection - laser cordectomy: 10 - 40 min.
- Hospitalization: 1-3 days
- Costs:
  - Laser cordectomy: 50000 Ft
  - versus external approach surgery or radiation therapy: 300000 - 500000 Ft
Conclusions

Laser cordectomy represents a minimally invasive, transoral surgical method with good oncological and good (type I,II,III) or acceptable (type IV,V,VI) functional results (quality of life).

There was no swallowing disorder.

• **Smoking** plays an important role in the development of glottic cancer in our patients too.
30 years experience with endolaryngeal CO2 laser surgery of the early supraglottic tumours

- Introduction of the transoral laser surgery of the T1, T2 supraglottic tumours (1989-)
Patient’s material: T1, T2 supraglottic tumours (1989-2010)

- 63 Patients (15%): transoral CO2 laser-resection (1989-2010)

- 85% of patients with supraglottic tumour underwent external approach surgical intervention (supraglottic laryngectomy, laryngectomy)
63 patients - staging

Transoral CO2 laser-resection

40 patients with tumour of the epiglottis (36 T1N0, 4 T1N1), 4 patients - tumour of the ventricular fold (4 T1N0), 13 patients with supraglottic-vallecula tumour (10 T2N0, 3 T2N1) and 6 patients with supraglottic-aryepiglottic fold (3 T2N0, 3 T2N1)

<table>
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<tr>
<th>Localization</th>
<th>Epiglottis</th>
<th>Ventricular fold</th>
<th>Supraglott.-vallecula</th>
<th>Supraglott.-aryepiglott. fold</th>
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</thead>
<tbody>
<tr>
<td>supraglott.</td>
<td>36 patients</td>
<td>4 patients</td>
<td>10 patients</td>
<td>3 patients</td>
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<tr>
<td>tumour</td>
<td>T1N0</td>
<td>T1N1</td>
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<td>Staging</td>
<td>4 patients</td>
<td>4 patients</td>
<td>3 patients</td>
<td>3 patients</td>
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<tr>
<td>Total</td>
<td>40 pat.</td>
<td>4 pat.</td>
<td>13 pat.</td>
<td>6 pat. = total of 63 patients</td>
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Patient’s material:
supraglottic tumours of the larynx (1989-2010)

• Transoral laser resection in 63 patients (40 patients with epiglottis tumour, 4 with ventricular fold, 13 with supraglottic-vallecula and 6 with aryepiglottic fold tumour)

• Of the 63 supraglottic carcinoma 10 patients underwent endolaryngeal laser excision which was combined with simultaneous modified neck dissection (mRND), (4 patients with tumour of the epiglottis (T1N1), 3 supraglottic-vallecula (T2N1) and 3 supraglottic-aryepiglottic fold tumour (T2N1) + primary neck metastases)

• 20 patients got radiation therapy
Supraglottic cancer T1 tumour of the epiglottis and after CO2 laser-resection (partial epiglottectomy)
Supraglottic CO2 laser resection

M. Csanády · L. Iván · J. Czigner

Endoscopic CO₂ laser therapy of selected cases of supraglottic marginal tumors

Eur Arch Otorhinolaryngol (1999) 256:392–394
Role of imaging (CT, MRI) in the transoral laser surgery of early (T1, T2) supraglottic tumours without infiltration of the preepiglottic space
Infrahyoid carcinoma of the epiglottis, early and late postoperative results after transoral laser resection

Without spreading to the preepiglottic space/ no detectable metastasis

Laser epiglottectomy (video)
Carcinoma of the supraglottic-vallecula
Endoscopic CO2 laser resection + mRND (video)
Tumour of supraglottic-aryepiglottic fold
Transoral laser resection (video)
Late postoperative functional result after transoral laser resection of supraglottic tumour (video)

No aspiration, glottis closure is intact
Results

- 47 (75%) patients with early supraglottic cancer became free of tumor after single laser resection
- 16 patients (25%) developed local recurrence
- 1 patient had irresecable neck metastasis (tumor free supraglottis), who died of metastases
- **Salvage-therapies** (16 patients): 7 repeated laser-resections, 3 radiation therapies, 4 horizontal supraglottic laryngectomies, 2 total laryngectomies, 5 RNDs (late neck metastases) – after **salvage therapies** there is no sign of recurrence
- Local tumor free survival: 85%
- Survival after salvage therapy: 98%
- Larynx sparing treatment: 96%
85% local tumour-free survival of supraglottic cancer patients after a transoral CO2 laser resection (Kaplan-Meier curve)

63 patients – T1, T2 supraglottic tumours
Cost benefit of transoral laser supraglottic resection

- Time of endoscopic surgical resection (laser supraglottic resection): 0.5 - 1h (versus horizontal supraglottic laryngectomy 1.5 - 2.5 h)
- Hospitalization: 3-8 days
- Average hospitalization time of transoral laser supraglottic resection: 6 days versus horizontal supraglottic laryngectomy 17 days

- Costs:
  - Laser supraglottic resection 70000 Ft + (neck dissection)
  - Horizontal supraglottic resection: 315000 Ft-
  - Depending on complications
Conclusions

• In selected patients with early supraglottic tumour (63 patients/15%) transoral laser resection proved to be a good endoscopic surgical option versus horizontal supraglottic laryngectomy

• In 10 patients transoral laser method was combined with neck dissection in one session

• There was no need for tracheostomy and postoperative aspiration was rarely severe depending on the extension of the resection

• Postoperative quality of life of transoral laser resection highly exceeds of external approach, horizontal supraglottic laryngectomy
Advantages of transoral CO2 laser technique

- Minimally-invasive surgical intervention - faster recovery
- No need for tracheostomy
- Minimal intraoperative bleeding
- No or moderate edema – rarely developed
- Moderate (severe) aspiration, but less deglutition problem than after open access surgery (partial laryngectomy)
- Acceptable - good swallowing and voice
- Feeding tube or PEG is rarely required, only after extensive transoral supraglottic resection
- Shorter hospitalization: 2-8 days vs. 1-3 weeks - cost benefit!
FUTURE: TRANSORAL ROBOT ASSISTED SURGERY (TORS)! – DA VINCI SURGICAL ROBOT
TRANSORAL ROBOT ASSISTED SURGERY (TORS) – DA VINCI
Thank you for your attention!