Updates in Transoral Laser Surgery of the Laryngeal Cancer

Robert Darling, MD
Michael Underbrink, MD
The University of Texas Medical Branch (UTMB Health)
Department of Otolaryngology
Grand Rounds Presentation
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Conflicts of interest

- I receive no monies for the advertisement, use, development or distribution of technologies/equipment/etc.
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Overview

- Review of Lasers
  - History
  - Mechanics
  - Safety
  - Types/Differences
- Recap of Laryngeal anatomy
- Overview of Tumor Staging
- Recent literature/developments
- Summary of recommendations
History

- Albert Einstein lays the theoretical foundations in his paper: *Zur Quantentheorie der Strahlung*, 1917
- The first Maser created in 1953
- Maiman fired the 1st prototype laser in 1960 (for ~1ms)
  - 1964 Nobel Prize given to Townes, Basov, and Prokhorov for their work on laser development
Relevant History

- CO_2_ laser developed in 1964 by Kumar Patel
- Polanyi developed the articulating arm for use in transoral surgery in 1968
  - Containing mirrors for beam transmission
- 1st time management of glottic carcinoma by way of transoral laser was described, 1972
- ~1998; flexible waveguides developed for transmission of CO_2_ laser
“Laser”

- Light Amplification by Stimulated Emission of Radiation
- Variety of different emission media available which determine frequency
- Monochromatic
- Coherent
- Collimated
Electromagnetic Spectrum
(in nanometers)

- Excimer: 190 - 390
- Argon: 488 - 514
- Dye: 577 - 630
- Ruby: 694
- Alexandrite: 755
- Nd:YAG: 1064
- Er:YAG: 2940
- CO₂: 10600
- Microwaves
  - TV and radio waves

UV: 400
Visible: 400 - 700
Infrared: 700 -
Adding energy to a medium will increase the spontaneous emission of that discrete energy level which will correspond to a specific wavelength.

Mediums can include gases, dyes, solid state chemicals, etc.
Physics

light is emitted by atoms

completely reflecting mirror

light is trapped in resonance between mirrors

partially reflecting mirror, feeds resonance, but also lets laser light escape.
Emission Modes

- Continuous
  - Relatively constant power
- Pulsed/Superpulsed (microsec)
  - Higher energy/shorter duration pulses
- Q-switched (nanosec)
  - Extremely high energy/short pulse duration
  - Has been used in KTP lasers for glottic carcinomas*
Properties of Lasers

- Absorption
- Reflection
- Scattering
- Transmission
Properties of Lasers

- Refraction: A surface phenomenon which allows for the bending of light at an incident angle
  - Critical Angle
  - Total internal reflection
  - Basis of fiber optics
Control of the Laser

• Tuning the utility to fit needs can by done by altering 3 variables
  • Power
    • Least useful*
    • Better represented by using the term irradiance (power/area of spot)
  • Spot Size
    • More often varied
    • If exposure time is constant, then irradiance is directly proportional to depth of tissue injury
  • Exposure Time
    • Can be Pulsed with variable time or continuous
Safety 1\textsuperscript{st}, 2\textsuperscript{nd}, and last

- **Eye protection**
  - Goggles people, wavelength specific; for everyone in the room as well as proper draping over the patient’s eyes

- **Skin protection**
  - Patient skin should be protected by double layer of moistened towels, this includes mucous membranes; only proximal end of laryngoscope should be unprotected
  - periodically remoisten

- **Teeth protection w/ telfa, sponges, etc**

- **Laser-safe airway (shielded tube or jet vent)**
  - O\textsubscript{2} less than 40\% when lasing, lowest O\textsubscript{2}\% that maintains pt oxygenation should be used
  - No N\textsubscript{2}O
  - Methylene Blue-saline should be used to inflate cuff

- **Smoke/Vapor suction**
  - Important to remove smoke/steam from operative field
  - Suction intermittently if on jet vent
  - CO\textsubscript{2} laser smoke condensate was thought to be mutagenic (1980s)
  - Actively suction when target tissue has high viral load (HPV)
Safety 1\textsuperscript{st}, 2\textsuperscript{nd}, and last
In the event of an airway fire...

- Rare occurrence, <200 OR fires per year in US total
- Recommendation is to:
  - Stop ventilation
  - Remove tube
  - Irrigation
  - Remove packing
  - Re-establish airway as soon as possible
  - Bronchoscopy to determine extent of damage, daily bronchoscopy until airway seen to be stable
- Steroids are a good idea
Laser types

- Commonly used in Laryngeal procedures
  - KTP
  - CO₂
  - Pulsed Dye
  - Tm:YAG
- Other
  - Nd:YAG
KTP Laser

- Potassium-Titanyl-Phosphate
- 532 nm wavelength
- KTP crystal used in conjunction with Nd:YAG laser
- Freely transmissible though flexible fibers
- May be operated continuously or pulsed (pulse width ~15ms)
  - The latter has been used for selective angiolysis of papillomas, dysplastic laryngeal lesions, and early glottic carcinomas*
CO2 Laser

- 10600 nm wavelength
  - Requires built in coaxial He-Ne laser, since CO2 laser is outside visible spectrum of light
- Strongly absorbed by water
- Minimal scattering and reflection
- Soft tissue vaporized
  - Surrounding vaporized tissue is a region of necrosis (0.1mm) and thermal conductivity and repair (<0.5mm)
- Thermocautery
Pulsed Dye Laser

- 585 and 595nm wavelengths have been used
- Short Pulse length (<0.5ms)
- Organic dye mixed into a solvent
- Photoangiolytic properties
- Absorbed preferentially by hemoglobin
  - Relatively tissue sparing
- Has been used for premalignant lesions, granulomas, and early glottic carcinomas
- Expensive
- Requires frequent repairs
Tm:YAG

- Thulium doped Yttrium-Aluminum-Garnet
- 2010 nm wavelength
- Easily conducted through a flexible fiber
- Functionally a hybrid between CO₂ and Pulsed dye
  - Thermal damage zone adjacent to cut was greater with thulium
  - Easily manipulated and directed
  - Solid state
  - Effective at tissue ablation at a distance of several mm to target
  - Effective at hemostatic cutting when in contact
  - Better thermal penetration than PDL
- New technologies are expensive
The others...

- Nd:YAG
  - Neodymium: Yttrium- Aluminum-Garnet
    - Solid state laser
  - 1064 nm wavelength
  - Transmits well through clear fluids
  - Scatters strongly
    - Produces a relatively large area of thermal coagulation and necrosis (up to 4mm lateral to the cut margins)
    - Precise control is impossible
    - Due to broad scattering, has good coagulation control
Targets for Laryngeal Transoral Laser Surgery

- Laryngeal cancers
- Papillomas
- Hemangiomas
- Anterior webs
- Cysts
- Polyps
- Nodules
- Granulomas
- Etc.
Refresher – Laryngeal Anatomy

- **Supraglottis**
  - Superior – Hyoid bone
  - Inferior – Apex of ventricle

- **Glottis (50-75% of primaries)**
  - Superior – Apex of ventricle
  - Inferior – 1 cm below the TVF

- **Subglottis (rarest site)**
  - Superior – 1 cm below the TVF
  - Inferior – Cricoid cartilage
Refresher – Laryngeal Anatomy
Staging – Supraglottis (2010 AJCC)

- **T1** – primary tumor limited to 1 subsite
- **T2** – primary tumor invades mucosa of more than 1 adjacent subsite of supraglottis or glottis (or BOT/vallecula, medial wall of piriform sinus)
- **T3** – Vocal fold fixation or invasion of post cricoid area, preepiglottic space, paraglottic space, or inner cortex of thyroid cartilage
- **T4** – further invasion
  - **T4a** – moderately advanced local disease
    - invasion through thyroid cartilage/beyond larynx
  - **T4b** – very advanced locally
    - Prevertebral space, mediastinum, encasing carotid
Staging – Glottis (2010 AJCC)

- **T1** – primary tumor limited to vocal folds (involving anterior or posterior commissure)
  - **T1a** – involvement of 1 vocal fold
  - **T1b** – bilateral VF involvement
- **T2** – primary tumor extends to supra/subglottis or impaired VF mobility
- **T3** – Fixed VF, invasion of paraaeglottic space, or invasion of inner cortex of thyroid cartilage
- **T4** – Further invasion
  - **T4a** – moderately advanced local disease
    - invasion through thyroid cartilage/beyond larynx
  - **T4b** – very advanced locally
    - Prevertebral space, mediastinum, encasing carotid
    - 25-40% local metastasis
Staging – Subglottis (2010 AJCC)

- **T1** – primary tumor limited to subglottis
- **T2** – primary tumor has VF involvement w/wo impairment of movement
- **T3** – primary tumor limited to larynx with fixed VF
- **T4** – further invasion
  - **T4a** – moderately advanced local disease
    - invasion through thyroid cartilage/beyond larynx
  - **T4b** – very advanced locally
    - Prevertebral space, mediastinum, encasing carotid
<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NX</td>
<td>Regional lymph nodes cannot be assessed.</td>
</tr>
<tr>
<td>No</td>
<td>No regional lymph node metastasis.</td>
</tr>
<tr>
<td>N1</td>
<td>Metastasis in a single ipsilateral lymph node, ≤3 cm in greatest dimension.</td>
</tr>
<tr>
<td>N2</td>
<td>Metastasis in a single ipsilateral lymph node, &gt;3 cm but ≤6 cm in greatest dimension.</td>
</tr>
<tr>
<td></td>
<td>Metastases in multiple ipsilateral lymph nodes, none &gt;6 cm in greatest dimension.</td>
</tr>
<tr>
<td>N2a</td>
<td>Metastasis in a single ipsilateral lymph node, &gt;3 cm but ≤6 cm in greatest dimension.</td>
</tr>
<tr>
<td>N2b</td>
<td>Metastases in multiple ipsilateral lymph nodes, none &gt;6 cm in greatest dimension.</td>
</tr>
<tr>
<td>N2c</td>
<td>Metastases in bilateral or contralateral lymph nodes, none &gt;6 cm in greatest dimension.</td>
</tr>
<tr>
<td>N3</td>
<td>Metastasis in a lymph node, &gt;6 cm in greatest dimension.</td>
</tr>
</tbody>
</table>
Why TLMS?

- Much less morbidity than open procedures
- Precise
- Good hemostatic properties
- Reduced laryngeal edema relative to electrocautery
- May adopt different lasers for different lesion types
- When comparing actual costs and hidden costs (work hours missed, travel time/distance etc), laser excision was cheaper than radiotherapy
- May allow for accurate staging of lesions
- Radiation therapy SEs include, but are not limited to:
  - Skin problems, xerostomia/loss of teeth, laryngeal edema/breathing problems, worsening hoarseness, tissue fibrosis, perturbations of taste
Why Not?

- Remains an invasive procedure
- Adverse effects are uncommon but can include:
  - Hemorrhage
  - Granuloma formation
  - Pneumothorax
  - Aspiration
  - Infection/Abscess formation
  - Anterior webs when AC involved
  - Airway fire/trauma
Functional Outcomes

• 2011 study by Kujath and associates comparing preservation of laryngeal function and need for laryngectomy at 5 years between TLMS and radiation therapy in patients with t1 or t2 glottic carcinomas

• Functional analysis included 79 pts (54 TLMS and 25 RT) in a prospective, non-randomized study evaluated at 3, 6, 12, and 24 mo
  • Testing included Performance Status Scale for Head and Neck Cancer Patients and Voice Handicap Index

• Oncologic analysis included 130 pts (54 TLMS and 76 RT) in a cohort study
Kujath 2011

Conclusions
- Functional - TLMS patients were more likely than RT patients to be hoarse (PSS-HN understandibility <100); however, vast majority were above 75. Additionally were more likely to have VHI-10 above 10.
- Oncologic – When laryngectomy free rates were compared (including partial), TLMS and RT were 87 vs 76% respectively at 5 years
  - P value of 0.16 limits the validity of any conclusions drawn from that data
- Oncologic – laryngeal preservation rate is 100 vs 86% p value of 0.02
- Increased likelihood of mild hoarseness in TLMS of low grade glottic cancers compared to RT; however, improved laryngeal preservation at 5 years and potentially lower incidence of laryngectomy.
“Experience is good, wisdom is better. On what should we rely on for treatment decisions - Anecdotes, opinions, and persuasion, or more objective data, systematic reviews, and thoughtful interpretation of available clinical reports? Use of the best information, thus minimizing bias and opinion, is the key element that separates ethical medical practitioners from quacks and charlatans.”

-Excerpt from a letter to the editor of Oto H&N Surgery by BW Blakely in 2009
Evidence Based Review

- Large Multicenter study by Hartl et al in November 2011 to evaluate the current levels of evidence for the various treatment options available for patients with glottic cancer
- Investigated evidence tiered into increasing tumor staging
Levels of evidence

- **I** – Large, randomized trials or meta-analyses of randomized trials
- **II** – Small randomized trials
- **III** – Non-randomized studies with contemporaneous controls
- **IV** – Non-randomized studies with historical controls
- **V** – Case studies with no controls
Hartl 2011

- T1a without AC involvement
  - Current guidelines have been developed after the sum of literature showed local control of 85-100% in various studies with TLMS and 84-95% with RT.
  - Based on level III and IV evidence
  - Only 1 study in Cochrane was a prospective randomized trial
    - Dey et al 2002
    - Fraught with methodicological errors prompting the researchers to conclude that their study had insufficient evidence
  - Remaining best evidence shows no statistically significant difference in local control or survival with TLMS or RT
  - Studies were split on voice handicap scores following TLMS vs RT, some demonstrating TLMS as more favorable; some with RT (all were level III)
Hartl 2011 – T1a

<table>
<thead>
<tr>
<th>Reference</th>
<th>No. of patients</th>
<th>Methodology</th>
<th>Group</th>
<th>Outcome</th>
<th>Evidence level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gourin et al.</td>
<td>89</td>
<td>Retrospective nonrandomized cohort, T1 all laryngeal sites</td>
<td>RT vs surgery</td>
<td>Survival: no difference</td>
<td>III</td>
</tr>
<tr>
<td>Jones et al.</td>
<td>364</td>
<td>Retrospective nonrandomized cohort, T1 glottic and supraglottic</td>
<td>RT vs surgery (laser or open resection)</td>
<td>Initial local control: no difference</td>
<td>III</td>
</tr>
<tr>
<td>Stoeckli et al.</td>
<td>101</td>
<td>Retrospective nonrandomized cohort, T1 glottic tumors</td>
<td>RT vs laser</td>
<td>Initial local control, survival: no difference</td>
<td>III</td>
</tr>
</tbody>
</table>

Abbreviation: RT, radiation therapy.
Hartl 2011

- T1a/b and T2 with AC involvement
  - Initially planned to examine t1a/b; however, literature was not arranged in that way
  - No specifics on whether or not the lesions in the studies were ulcerated, AC primary site, infiltrating, etc
  - Not all T2 tumors are alike
- Such tumors present anatomical problems for tumor spread
  - Proximity to thyroid cartilage; absence of conus elasticus or perichondrium
- Studies are split between TLMS and RT for best local control in tumors involving the AC.
Hartl 2011 – involving AC

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<tbody>
<tr>
<td>Sachse et al.</td>
<td>119</td>
<td>Retrospective nonrandomized cohort</td>
<td>Open surgery vs laser</td>
<td>Local control: no difference</td>
<td>III</td>
</tr>
<tr>
<td>Bron et al.</td>
<td>156</td>
<td>Retrospective nonrandomized cohort</td>
<td>Surgery (laser or open) vs RT</td>
<td>Initial local control and final laryngeal preservation: surgery better than RT</td>
<td>III</td>
</tr>
<tr>
<td>Zohar et al.</td>
<td>67</td>
<td>Retrospective nonrandomized cohort</td>
<td>Open surgery vs RT</td>
<td>Initial local control: open surgery better than RT</td>
<td>III</td>
</tr>
<tr>
<td>Rucci et al.</td>
<td>182</td>
<td>Retrospective nonrandomized cohort</td>
<td>Open surgery vs RT</td>
<td>Initial local control: RT better than surgery</td>
<td>III</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Final local control (after surgical salvage): initial surgery better than initial RT</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: RT, radiation therapy.
Hartl 2011

- T2 w/wo impaired VF mobility
  - Initial local control rates for RT, vs, open surgery, vs TLMS are comparable (level IV evidence)
  - No compelling evidence in favor of surgery vs RT (level III)
    - Supracricoid partial favored over vertical partial if open surgery chosen
  - When stratified into subgroups
    - RT local control falls to 76% in T2 patients with impaired VF mobility
    - TLMS local control drops to 17% in T2 tumors with deep extension into paraglottic space, extension to the roof of the ventricle, and false VF (level III)
  - Not all T2 lesion are the same, specifics affect prognosis

<table>
<thead>
<tr>
<th>T classification</th>
<th>Open cordectomy 12-14</th>
<th>Frontal anterior laryngectomy 12,15,16</th>
<th>Hemilaryngectomy 11,17-23</th>
<th>Frontal anterior laryngectomy 16,24,25</th>
<th>SCPl 26-33</th>
<th>Laser 5-11,34-46</th>
<th>RT 47-66</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1a</td>
<td>90% to 100%</td>
<td>93% to 96%</td>
<td>91% to 100%</td>
<td>100%</td>
<td>98% to 100%</td>
<td>85% to 100%</td>
<td>84% to 95%</td>
</tr>
<tr>
<td>T1a-b and T2 AC</td>
<td>—</td>
<td>93% to 96%</td>
<td>86% to 98%</td>
<td>100%</td>
<td>98% to 100%</td>
<td>70% to 95%</td>
<td>T1: 43% to 91%</td>
</tr>
<tr>
<td>T2</td>
<td>—</td>
<td>92%</td>
<td>69% to 78%</td>
<td>92% to 94%</td>
<td>88% to 96%</td>
<td>66% to 100%</td>
<td>T2*: 58% to 74%</td>
</tr>
</tbody>
</table>

Abbreviations: AC, anterior commissure; SCPl, supracricoid partial laryngectomy; RT, radiation therapy.
* Mixed cohorts.
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<tbody>
<tr>
<td>Gourin et al(^{68})</td>
<td>98</td>
<td>Retrospective nonrandomized cohort, T2 all laryngeal sites</td>
<td>RT vs surgery</td>
<td>Survival: no difference</td>
<td>III</td>
</tr>
<tr>
<td>Jones et al(^{50})</td>
<td>124</td>
<td>Retrospective nonrandomized cohort</td>
<td>RT vs surgery (laser or open resection)</td>
<td>Initial local control: no difference</td>
<td>III</td>
</tr>
<tr>
<td>Stoeckli et al(^{69})</td>
<td>39</td>
<td>Retrospective nonrandomized cohort</td>
<td>RT vs laser</td>
<td>Initial local control and final laryngeal preservation: surgery better than RT</td>
<td>III</td>
</tr>
<tr>
<td>Marandas et al(^{33})</td>
<td>66</td>
<td>Retrospective nonrandomized cohort, T2 with impaired mobility</td>
<td>RT vs open surgery</td>
<td>Initial local control surgery 88%, RT 79% (no statistical analysis)</td>
<td>III</td>
</tr>
</tbody>
</table>

Abbreviation: RT, radiation therapy.
No studies demonstrating a strong role of TLMS in resection were examined in this paper.

Ongoing debates regarding Chemotherapy and/or RT and/or open surgery are beyond the scope of this lecture.

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</tr>
</thead>
<tbody>
<tr>
<td>Wolf et al105</td>
<td>332</td>
<td>Prospective randomized, larynx</td>
<td>TL + RT vs Induction chemo+ RT in responders</td>
<td>Overall survival: no difference; 64% larynx preservation</td>
<td>I</td>
</tr>
<tr>
<td>Forastiere et al98</td>
<td>547</td>
<td>Prospective randomized, larynx</td>
<td>CRT vs chemo+ RT in responders vs RT</td>
<td>Overall survival: no difference. Disease-free survival: better if CRT or chemo. Larynx preservation best for CRT (88%)</td>
<td>I</td>
</tr>
<tr>
<td>Bonner et al100</td>
<td>424</td>
<td>Prospective randomized, all head and neck sites (1/4 larynx)</td>
<td>RT + cetuximab vs RT</td>
<td>Overall survival and locoregional control; RT + cetuximab better</td>
<td>I</td>
</tr>
<tr>
<td>Posner et al106</td>
<td>501</td>
<td>Prospective randomized, all head and neck sites (18% larynx)</td>
<td>Induction TPF vs chemo+ both followed by CRT</td>
<td>Overall survival and locoregional control; TPF better</td>
<td>I</td>
</tr>
<tr>
<td>Pontreau et al107</td>
<td>213</td>
<td>Prospective randomized, larynx + hypopharynx</td>
<td>Induction TPF vs chemo+ both followed by RT or CRT in responders</td>
<td>Organ preservation: TPF better (70% vs 58%)</td>
<td>I</td>
</tr>
<tr>
<td>Bourhis et al101</td>
<td>6,515</td>
<td>Meta-analysis prospective randomized trials (head and neck, all sites)</td>
<td>Hyperfractionated or accelerated RT vs RT</td>
<td>Overall survival and locoregional control: altered fractionation better</td>
<td>I</td>
</tr>
<tr>
<td>Pignon et al109</td>
<td>17,346</td>
<td>Meta-analysis prospective randomized trials (head and neck, all sites)</td>
<td>CRT vs sequential chemotherapy and RT vs RT</td>
<td>Overall survival better if chemotherapy; CRT better than other regimens</td>
<td>I</td>
</tr>
<tr>
<td>Hoffman et al110</td>
<td>158,426</td>
<td>Retrospective database (larynx all sites)</td>
<td>Treatments 1985–2001 (surgery vs RT vs CRT)</td>
<td>Overall survival: —decrease for T3N0 supraglottic but not for T4N0 or T3N+; —no significant decrease for T3N0 glottic and no difference between CRT and TL + RT (66%), but RT alone worse (48%)</td>
<td>III</td>
</tr>
<tr>
<td>Chen et al111</td>
<td>7,019</td>
<td>Retrospective database (larynx all sites)</td>
<td>TL vs RT vs CRT or sequential chemotherapy (chemo-RT)</td>
<td>Overall survival: stage III: TL and chemo-RT better than RT; stage IV: TL better than chemo-RT or RT</td>
<td>III</td>
</tr>
<tr>
<td>Gourin et al115</td>
<td>451</td>
<td>Retrospective database (larynx all sites)</td>
<td>Surgery vs RT vs CRT</td>
<td>Overall survival: stage III: no difference between surgery and CRT/RT but CRT better than RT; stage IV: surgery better than CRT or RT</td>
<td>III</td>
</tr>
</tbody>
</table>
Hartl 2011

- Overall conclusions for low grade tumors
  - Higher level evidence needed
  - No significant difference in local control or vocal function between TLMS and RT for T1a lesions not involving the AC
  - Studies are split between TLMS and RT for best local control in T1-2 tumors involving the AC
  - Not all T2 tumors are the same
    - RT local control falls to 76% in T2 patients with impaired VF mobility
    - TLMS local control drops to 17% in T2 tumors with deep extension into paraglottic space, extension to the roof of the ventricle, and false VF
Treatment for Intermediate Grade lesions (t2-3)

- 2013 study in Otolaryngology -- Head and Neck Surgery looked at Oncologic and Functional Outcomes of Partial Laryngeal Surgery for Intermediate-Stage Laryngeal cancers (T2-3)
  - Transoral laser microsurgery with CO2 laser vs Supracricoid laryngectomy
  - Procedures performed with curative intent
- Retrospective review of 60 patients (28 TLMS and 32 SCL) at Pittsburgh from 1998-2010
  - Contraindications: complete resection with negative margins was not technically feasible; tumor substantially (.5 mm) involved the base of the tongue, extended .10 mm into the subglottis, or grossly invaded extralaryngeal structures; presence of >N1 nodal neck disease
  - 44/60 underwent neck dissection, 12/60 demonstrated nodal disease, 25% of total patients were given RT postoperatively (most had concurrent chemo)
- Functional evaluation done via Communication Scale (CS) for speech and the Functional Outcome Swallowing Scale (FOSS) for swallowing
- Oncologic endpoints were overall survival (OS), recurrence-free survival (RFS), and time to recurrence (TTR)
## Caicedo-Granados 2013

<table>
<thead>
<tr>
<th></th>
<th>All Patients (n = 60)</th>
<th>TLM Cohort (n = 32)</th>
<th>SCL Cohort (n = 28)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean age, y (range)</strong></td>
<td>61 (43-80)</td>
<td>61 (43-80)</td>
<td>62 (48-74)</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>46</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>Female</td>
<td>14</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td><strong>Larynx subsite</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glottic</td>
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<td>III</td>
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</table>

**Abbreviations:** AJCC, American Joint Committee on Cancer; SCC, squamous cell carcinoma; SCL, supracricoid partial laryngectomy; TLM, transoral laser microsurgery.
Caicedo-Granados 2013

• Results
  • There was no difference in OS, RFS, or TTR between the TLM and SCL groups.
    • The 2- and 5-year OS probabilities were 86.2% (95% CI, 73.0%-93.2%) and 72.9% (95% CI, 52.4%-85.6%), respectively
    • The 2- and 5-year RFS probabilities were 79.3% (95% CI, 65.6%-88.0%) and 62.4% (95% CI, 41.9%-77.4%)
  
• Functional
  • There was a significant worsening in both CS and FOSS between diagnosis/surgery and last follow-up (avg 33mo) in the SCL cohort but not in the TLM cohort
    • Greater than 90% were considered to have a functioning larynx in both groups
Other observations

- Partial laryngeal surgery enables determination of accurate pathological staging, which is used to precisely direct adjuvant therapy and allows further risk stratification.
- Having definitive staging allowed 75% (69% of TLM and 81% of SCL) of patients in the entire cohort to avoid RT.
- Difference likely due to higher proportion of supraglottic ca in TLM group; higher rate of nodal metastasis
TLMS in high grade lesions

- Study in 2007 at Mayo clinic by Hinni et al in Archives of Otolaryngology Head and Neck Surgery
  - Prospective case series involving 117 patients with Pathologically confirmed T2-T4, stage III or IV, glottic and supraglottic tumors
  - Min. f/u of 24 months
  - TLMS in 117 patients, SND in 92, adjuvant RT in 45, adjuvant chemotherapy in 4
  - Exclusions:
    - Inadequate endoscopic access, extension of tumor or nodes to encase great vessels, marked extension of primary tumor, and any tumor extension that would put complete resection at risk to cause aspiration (e.g. bilateral arytenoid involvement)
    - Select T4 tumors penetrating the cartilage or >1cm into tongue base were still allowed into the study
Hinni 2007

- Primary tumor removed with an **incisional resection** technique
  - Piece by piece division of tumor
  - Allows for accurate mapping of tumor/host interface
  - Allows for maximum amount of ‘normal’ tissue to remain

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All Patients (N=117)</th>
<th>TLM Alone With or Without Neck Dissection (n=72)</th>
<th>TLM With or Without Neck Dissection, With Adjuvant RT (n=45)</th>
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</table>
Hinni 2007

- Complications
  - 4 died, 3 from unknown causes within 30 days of treatment
  - 6 bled at primary site requiring intervention
  - 4 developed redundant arytenoid tissue requiring TLMS to reduce, 2 went on to have temporary trachs, 2 for permanent for supraglottic stenosis
Hinni 2007

Results

- Substratifying analysis not performed by tumor stage, treated as large cohort
- Overall and disease-free survival did not differ substantially between patients treated with TLM alone and patients treated with TLM and adjuvant RT.

Laryngectomy free survival

- 2 years - 70% (95% CI, 62%-78%) – OS 75%
- 5 years - 51% (95% CI, 41%-61%) – OS 55%

Functional

- 30 assessed for FOSS stage – median was stage 1 (normal function with episodic/daily symptoms of dysphagia)
- 28 assessed for CS score – median was stage 2 (grossly dysphonic)
Hinni 2007

- **Comparison**
  - Current study OS rates at 2 and 5 years of 75% and 55% respectively
  - 74% and 54% for CRT
  - 75% and 65% for RT alone (RTOG 91-11)
  - Current study had a higher %T4 tumors than the RTOG or CRT studies they were comparing to
  - Results challenge the conclusions of the non surgical papers
  - Choice of TLMS largely up to the experience and preference of the operating surgeon
Physician Preferences

- Since evidence has yet to demonstrate one treatment option which is head and shoulders above the rest, physicians remain divided.
  - SurveyMonkey!
Researchers developed a questionnaire on Surveymonkey which was distributed to H&N surgeons (40) and Radiation oncologists (562)

- Participants stratified on the basis of number of new glottic ca. patients per year, length of time in practice, practice setting, etc
- Questioned on treatment strategy of T1 (a/b), T2 (a/b), T3, and T4a. No and Mo
Makki 2011

<table>
<thead>
<tr>
<th>Initial Treatment</th>
<th>T1a, n (%)</th>
<th>T1b, n (%)</th>
<th>T2a, n (%)</th>
<th>T2b, n (%)</th>
<th>T3, n (%)</th>
<th>T4a, n (%)</th>
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<td>ROs</td>
<td>H&amp;N Surgeons</td>
<td>ROs</td>
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</table>

\[ p \text{ value} \]

H&N = head neck; NS = not significant; RO = radiation oncologist; TLM = transoral laser microsurgery; XRT = radiation therapy.
*CO₂: Carbon dioxide.
Makki 2011

- 25 (40%) H&N surgeons and 115 (20%) of ROs responded
- **HEAVY specialty bias with low-grade cancers**
- Agreement on higher grade lesions
- A higher % of surgeons preferred frozen sections to permanent for margins
- Surgeons averaged a 3mm preference in margins, ROs preferred >5 on average
- **If margins positive, surgeons preferred resection to radiation therapy (compared to ROs preference)**
- Compared to previous studies, this represents a somewhat dramatic shift in the H&N surgeon preference for low-grade cancers
Summary

- A variety of different laser mediums allow for lasers with different properties.
  - The technology is constantly evolving
- The first rule of lasers is safety
  - The second rule of lasers is safety!
- Vocal outcomes in TLMS are generally good for low grade lesions
- Specific high-grade lesions may be eligible for incisional resection with outcomes comparable to non-surgical options
- Current recommendations are based on low level evidence
- The current data supports no firm conclusions regarding definitive treatment options
  - “Different strokes”
  - Underscores need for high level, definitive evaluation of modalities
Bibliography

- Pasha. Otolaryngology Head and neck surgery 3rd edition. pp299-311
Great moments in laser history