



Robotic Surgery in Head & Neck Cancer: Implementing new technology to meet the needs of the HPV epidemic

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Disclosures



- None

Outline

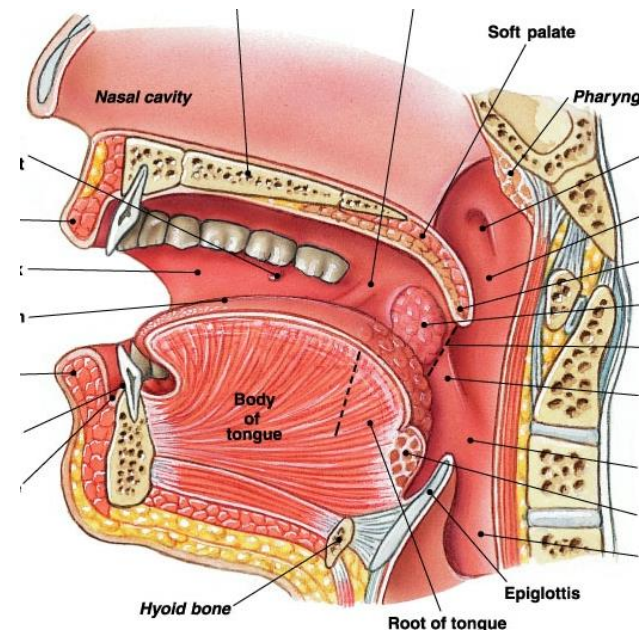


- Emergence of HPV-associated cancer
- Evolution of surgical approaches
- Robotic Operative Consideration
- Oncologic & functional outcomes
- Future directions of robotic surgery

Head & Neck Cancer



- 6th most common solid cancer in the world
 - 52,000 new cases annually in the U.S.
- Originate in the upper aerodigestive tract
 - Important functional roles of respiration, speech, and swallowing.
- Over three consecutive decades, the incidence of head and neck cancer has declined



Emergence of HPV – Oropharyngeal Cancer



Tongue and Tonsil Carcinoma

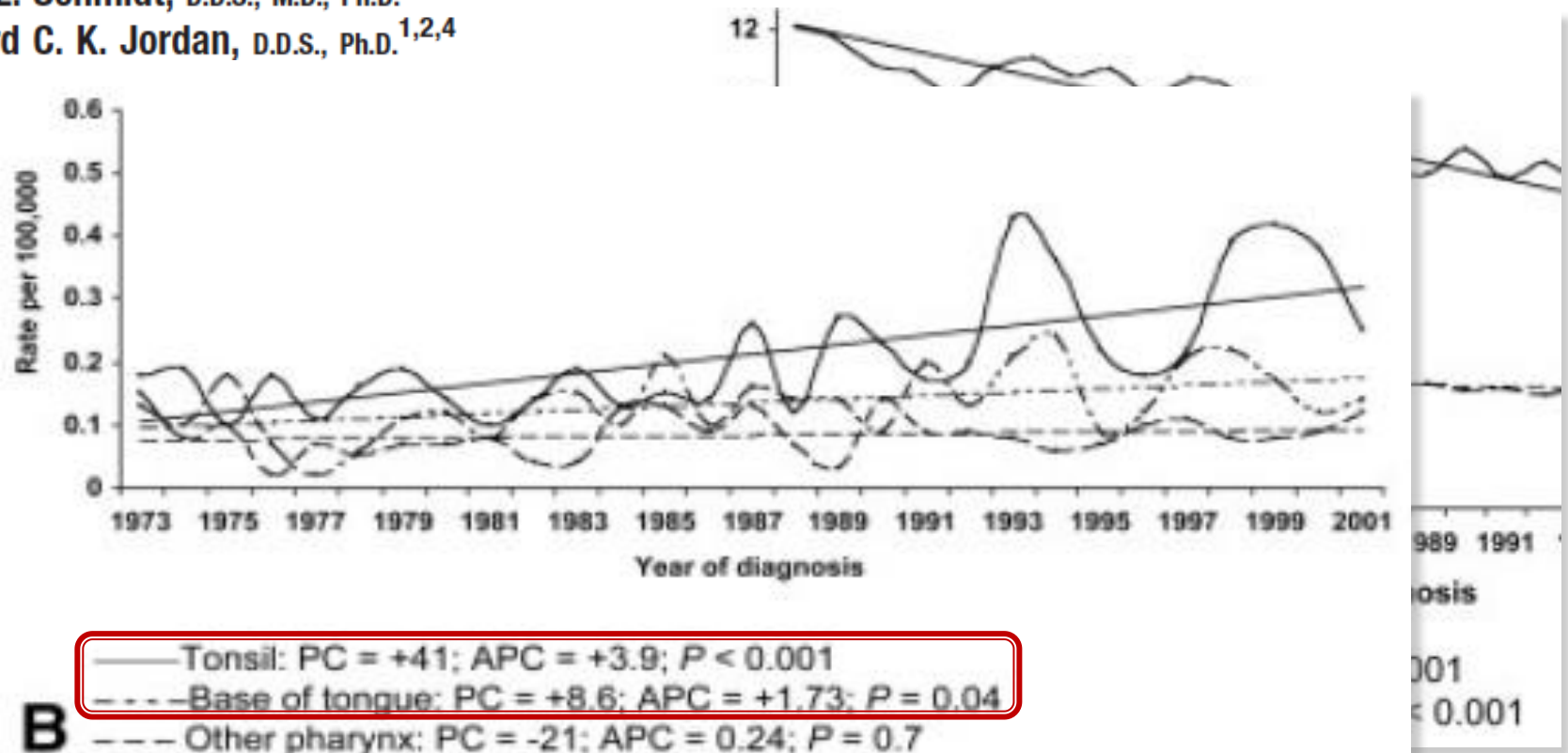
Increasing Trends in the U.S. Population Ages 20–44 Years

Caroline H. Shiboski, D.D.S., M.P.H., Ph.D.^{1,2}

Brian L. Schmidt, D.D.S., M.D., Ph.D.^{2,3}

Richard C. K. Jordan, D.D.S., Ph.D.^{1,2,4}

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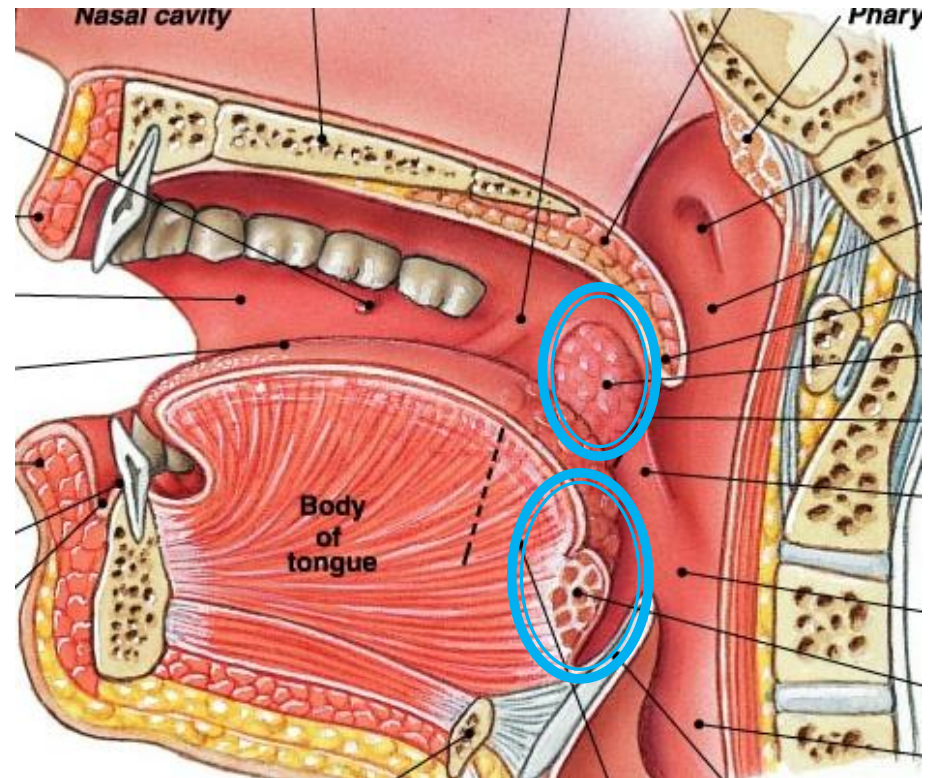
■ 1973-2001

Shiboski, C. H., Schmidt, B. L., & Jordan, R. C. K. (2005). Tongue and tonsil carcinoma. *Cancer*

Oropharynx – Anatomy



- Subsites
 - Base of Tongue
 - Palatine Tonsil
 - Soft Palate
 - Posterior Pharynx

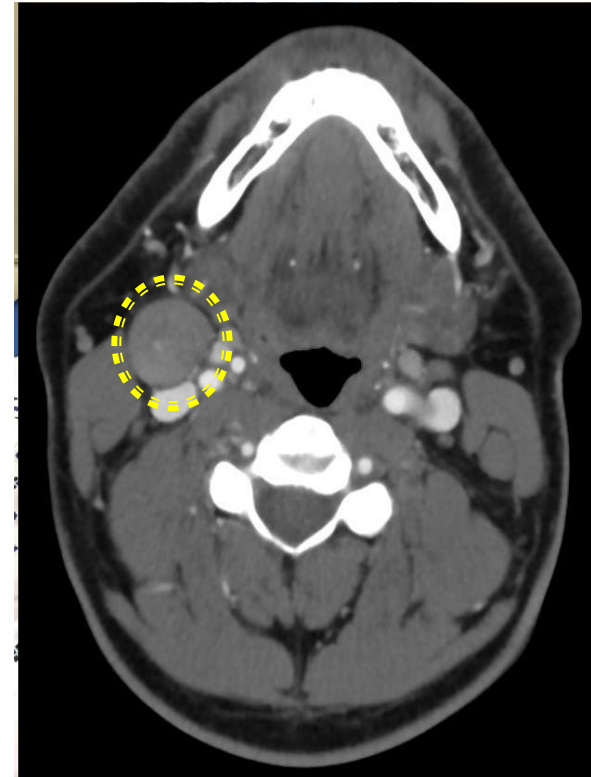


Moore, E. J et al (2009). Transoral robotic surgery for oropharyngeal squamous cell carcinoma: A prospective study of feasibility and functional outcomes. *The Laryngoscope*, 119(11), 2156–2164.

Case



- 42 year old male with a 8 month history of right neck mass.
 - No history of smoking or EtOH use
 - CT demonstrated a 3cm neck mass
 - Needle Aspirate/Biopsy:
 - Squamous Cell Carcinoma – **HPV**
- Surgeon Identified
 - Right Base of Tongue Cancer



Emergence of HPV- Oropharyngeal Cancer

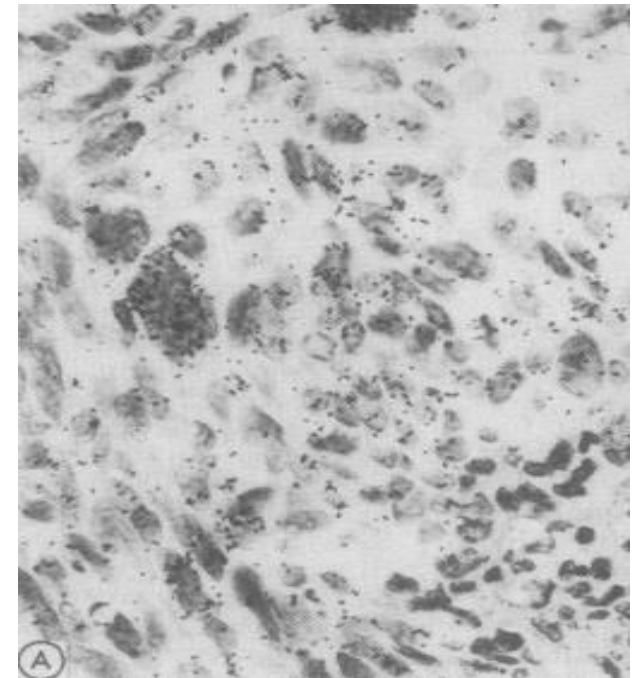


J Clin Pathol 1990;43:918–921

Detection of human papillomavirus type 16 DNA in carcinomas of the palatine tonsil

G Niedobitek, S Pitteroff, H Herbst, P Shepherd, T Finn, I Anagnostopoulos, H Stein

- Immunohistochemical investigation of DNA viruses association with oropharyngeal squamous cell carcinoma
 - EBV
 - CMV
 - HPV: 6,11,16
 - **HPV 16: 6/28 (21%)**



Niedobitek, G et al. (1990). Detection of human papillomavirus type 16 DNA in carcinomas of the palatine tonsil. *Journal of Clinical Pathology*

Emergence of HPV – Oropharyngeal Cancer



Human Papillomavirus and Rising Oropharyngeal Cancer Incidence in the United States

Anil K. Chaturvedi, Eric A. Engels, Ruth M. Pfeiffer, Brenda Y. Hernandez, Weihong Xiao, Esther Kim,

- Features of HPV Positive Cancers:
 - Risk factors are related to sexual behavior
 - Affects white males less than 60 years of age
 - Population-level incidence increased by 225% (1998-2004)
- Annual incidence of HPV oropharyngeal cancer have surpassed cervical cancers

Emergence of HPV-Oropharyngeal Cancer



■ 3-Year Oncologic Outcomes

■ Overall Survival

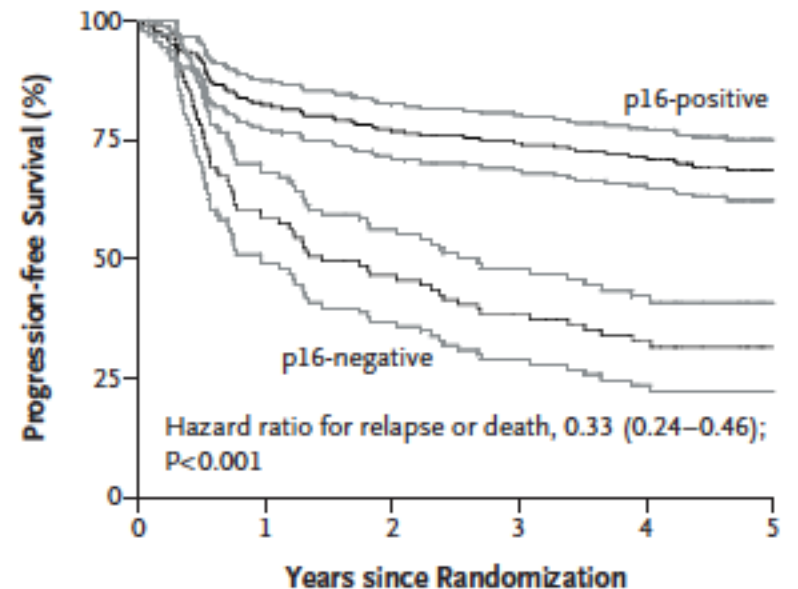
- HPV(+) - 82.4%
- HPV(-) - 57.1%

■ Progression Free Survival

- p16(+) - 74.4%
- p16(-) - 38.4%

- The “risk of death” rose 1 for each pack-year of tobacco smoking

D Progression-free Survival According to p16 Expression



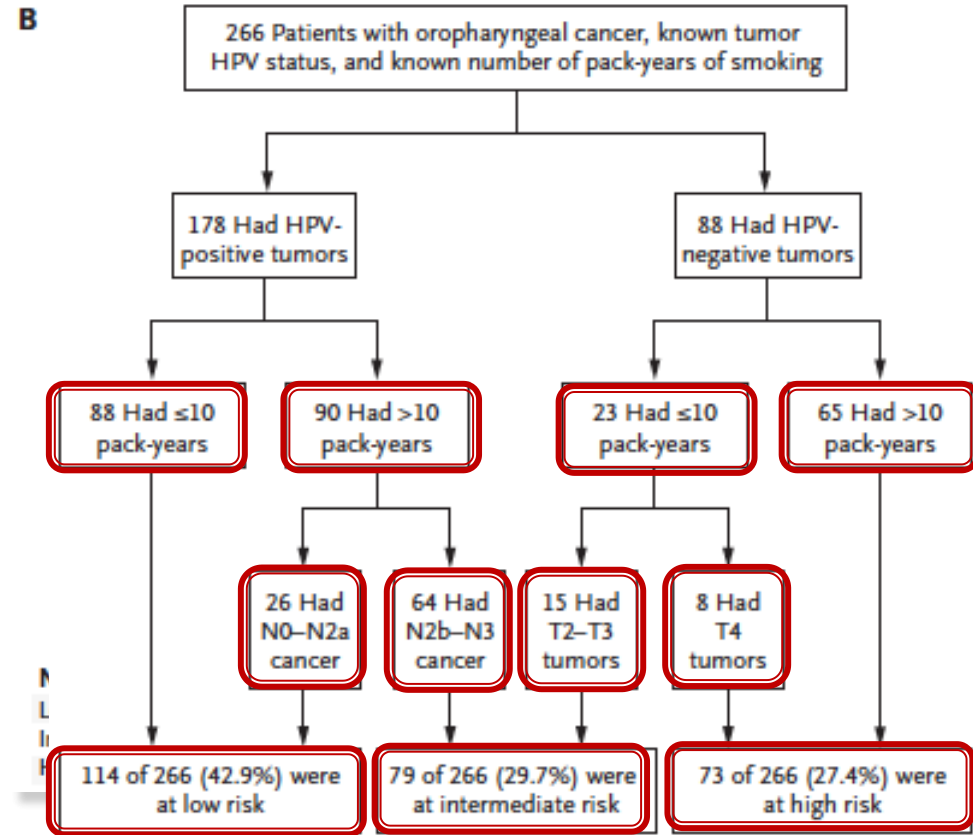
No. at Risk	0	1	2	3	4	5
p16-positive	215	177	164	156	143	66
p16-negative	101	59	46	37	25	11

Emergence of HPV-Oropharyngeal Cancer



Viral features and smoking history classify oncologic risk profile.

- **Low:** 93% overall survival at 3 years
- **Intermediate:** 71% overall survival at 3 years
- **High:** 46% overall survival at 3 years



AJCC Staging



Pathological TNM Stage Grouping 8th Ed. p16+ Oropharyngeal Cancer

	N0	N1	N2
T0	I	I	II
T1	I	I	II
T2	I	I	II
T3	II	II	III
T4	II	II	III





Original Investigation

Initial Symptoms in Patients With HPV-Positive and HPV-Negative Oropharyngeal Cancer

Wesley R. McIlwain, BS; Amit J. Sood, BA; Shaun A. Nguyen, MD, MA; Terry A. Day, MD

- 88 patients evaluated from 2008-2013
- Initial chief complaints
 - **Neck Mass:** 51% of HPV(+) v. 18% HPV(-)
 - **Sore Throat:** 28% of HPV(+) v. 53% of HPV(-)

Epidemiology - Summary



- HPV-associated oropharyngeal cancer is rising in incidence every year.
- Patients have an improved prognosis compared to tobacco-mediated cancers
- Cervical lymph node metastasis is the most common presentation.
- Improved survival has resulted in a new cancer staging schema.
- **Should we therefore adopt a new treatment paradigm?**

Outline



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Historical Background

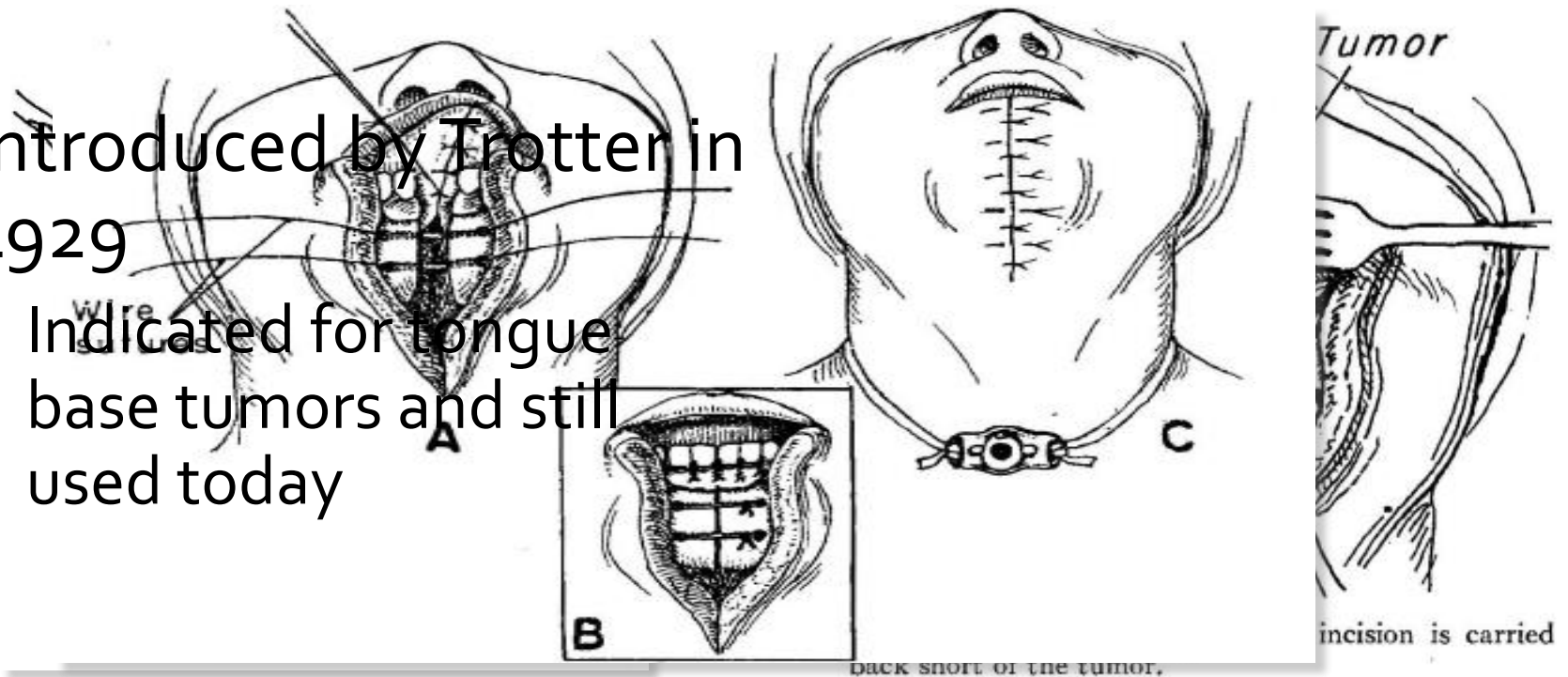


Median Labiomandibular Glossotomy

TROTTER'S MEDIAN (ANTERIOR) TRANSLINGUAL PHARYNGOTOMY

HAYES MARTIN, M.D., H. RANDALL TOLLEFSEN, M.D. AND FRANK P. GEROLD, M.D.,
New York, New York

- Introduced by Trotter in 1929
 - Indicated for tongue base tumors and still used today



Median labiomandibular glossotomy. Trotter's median (anterior) translungual pharyngotomy. (1961). 102, 753-759.
American Journal of Surgery

Historical Background

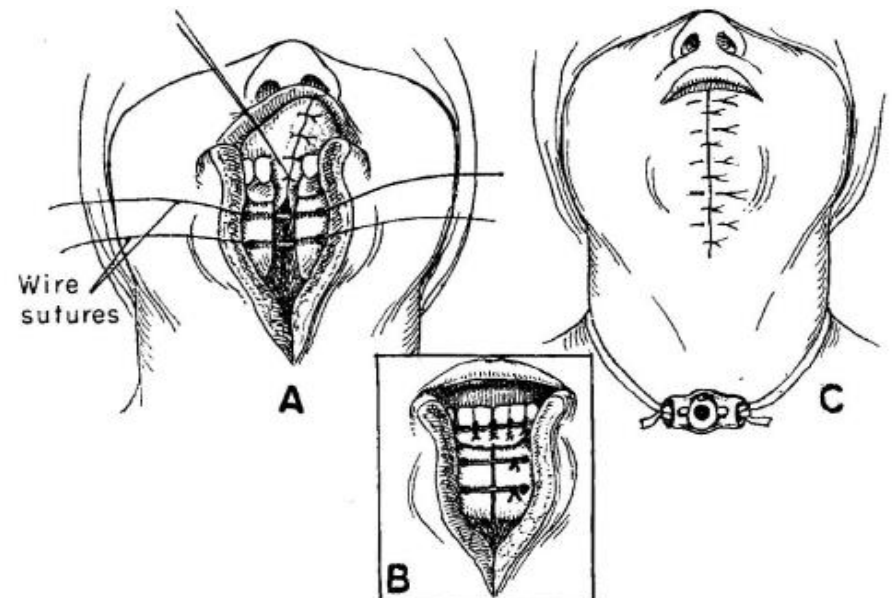


Median Labiomandibular Glossotomy

TROTTER'S MEDIAN (ANTERIOR) TRANSLINGUAL PHARYNGOTOMY

HAYES MARTIN, M.D., H. RANDALL TOLLEFSEN, M.D. AND FRANK P. GEROLD, M.D.,
New York, New York

- Technical Considerations:
 - Tracheostomy
 - Mandibulotomy
 - Wiring of mandible and teeth for "several weeks"



Introduction of Transoral Surgery



The Laryngoscope
Lippincott Williams & Wilkins, Inc.

Robot-Assisted Pharyngeal and Laryngeal Microsurgery: Results of Robotic Cadaver Dissections

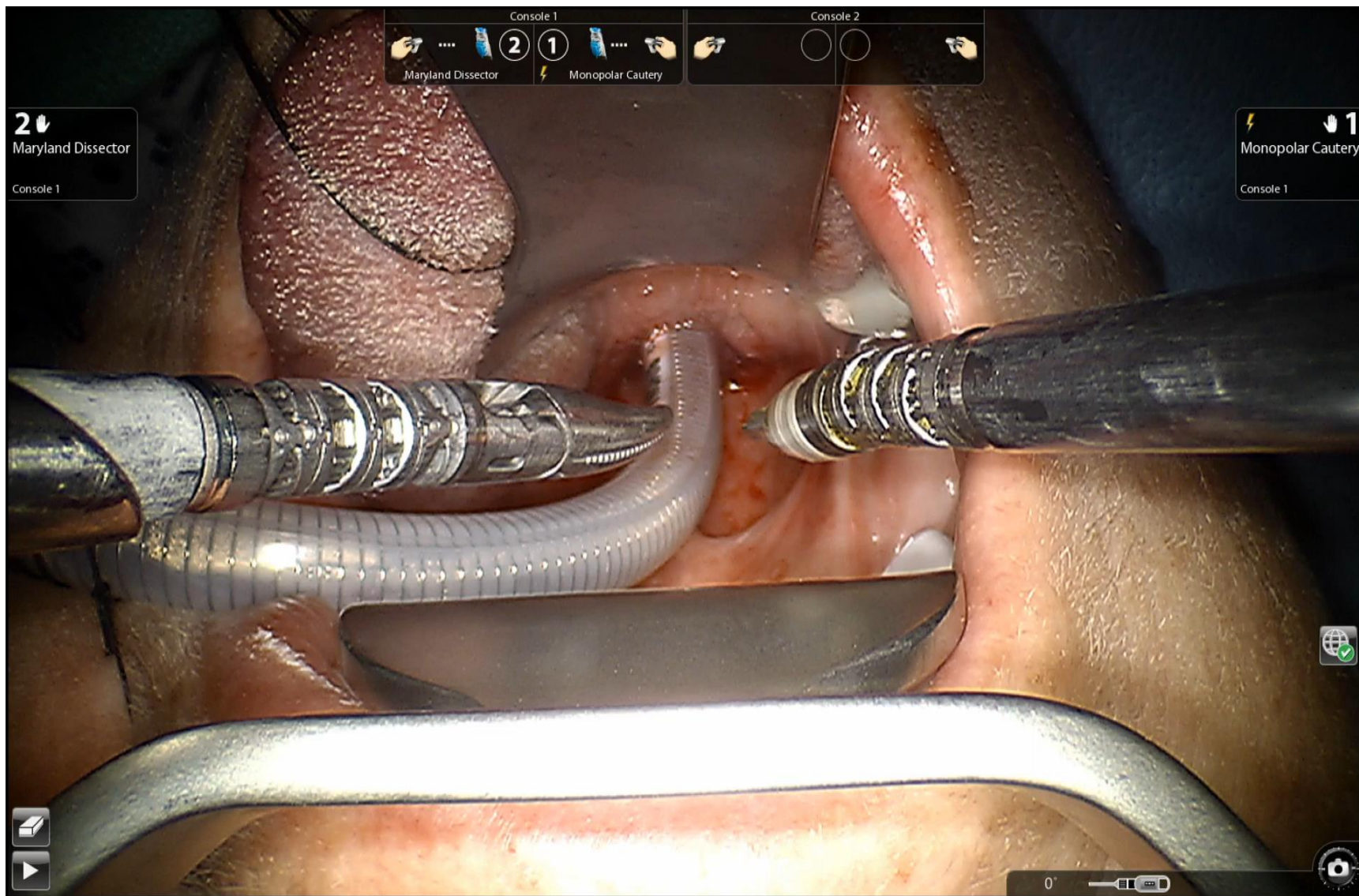
Neil G. Hockstein, MD; J. Paul Nolan, BS; Bert W. O'Malley, Jr, MD; Y. Joseph Woo, MD

- Cadaveric dissection assessing the feasibility and safety of robotic instrumentation.



- Hockstein, N. G et al (2005). Robot-assisted pharyngeal and laryngeal microsurgery: results of robotic cadaver dissections. *The Laryngoscope*
- Hockstein, N. G. et al(2006). Assessment of Intraoperative Safety in Transoral Robotic Surgery. *The Laryngoscope*, 116(2), 165–168.

TORS – Oropharynx



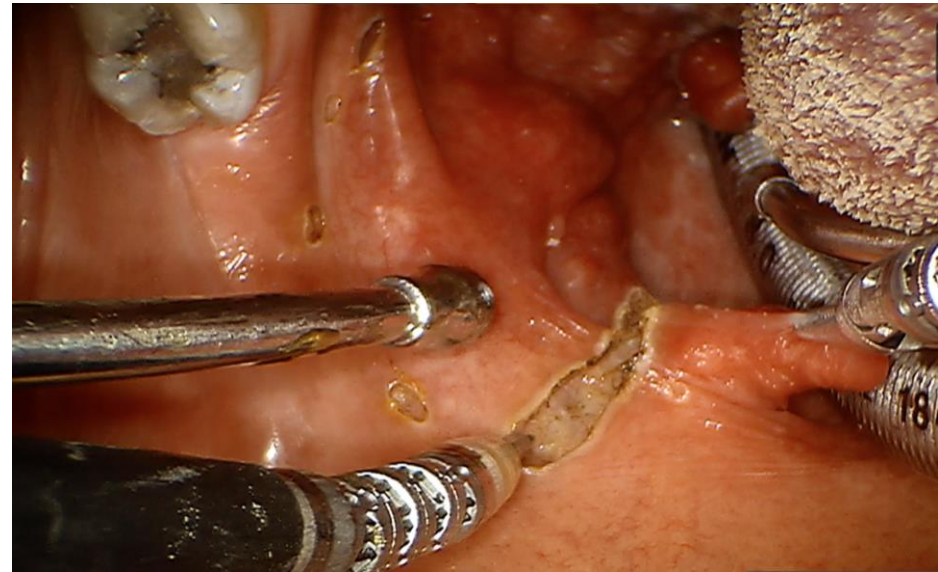
Indications for TORS



- In 2009, the FDA approved TORS for all early stage cancers of the oral cavity, pharynx, and laryngeal lesions.

- Contraindications:

- Mandibular Invasion
- Carotid artery encasement
- Fixation to the prevertebral fascia



- Weinstein, G. et al. (2007). Transoral robotic surgery: radical tonsillectomy. Archives of Otolaryngology--Head & Neck Surgery, 133(12), 1220–1226.

Advancement of TORS Surgery



- Wide-field high definition three-dimensional optics for the surgeon

- Surgeon assistant at bedside allows access of assistant for 4-handed surgery



Advantages of TORS



- Decreased dependence on feeding tube placement
 - 2% compared to 10% following chemoradiation
- Decreased intraoperative blood loss
 - 50ml v. 300ml with open surgery
- Reduced length of hospital stay
 - 3.8 days *versus* 8 hospital days
- Potential to avoid need for additional treatment (radiation and/or chemotherapy)

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Surgical Room Set-Up



- Instruments
 - 3-arm surgery
 1. Central Camera/Scope
 2. Monopolar Cautery
 3. Maryland Dissector

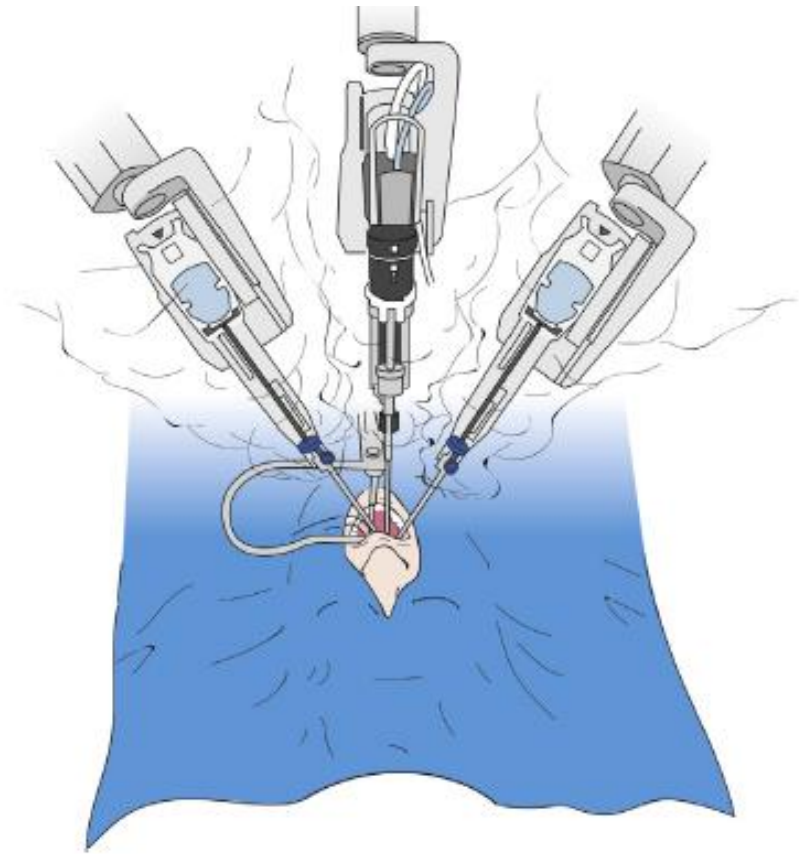
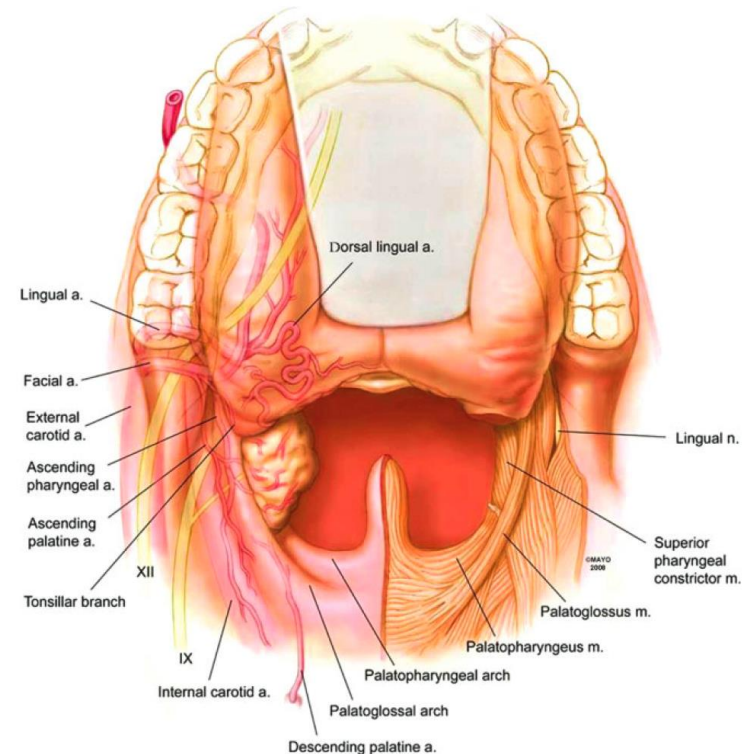


Figure 6. Illustration of a patient undergoing TORS. An oral retractor mouth gag is placed to aid visualization of the operative site. *Illustration courtesy of Kurt Jones.*

Risks of Robotic Surgery



- Intraoperative Complications:
 - Facial Trauma
 - Lip/Dental Injury - 1.4%
 - Bleeding (Lingual Artery)
- Post-Op Complications
 - Bleeding (3-8%)
 - Pain → Dehydration (2%)
 - Need for gastrostomy tube (2%)



Advancements

- **Dexterity:**
 - Triangulate Instruments at the Distal Tip
 - Control three *wrists* *and elbows* instruments



Advancements

- **Visualization**
 - Ability to modify the axis of rotation of the boom
 - Articulating Camera Arm
 - “Cobra Mode”



Advancements

- Hemostasis
 - Bipolar cauterization with Maryland forceps



Key Advantages of Sp Technology



- Room Set Up
 - *Reduction in the amount of OR set up time*
- Exposure
 - Increase in the % of cases for base of tongue resections
- Access
 - Changing the angle of exposure with boom
- Hemostasis
 - Bipolar hemostasis reduces the amount of thermal injury

Training – Interprofessional Team



- Jumping ahead 2 generations
 - Upgrade from Si to SP
- Training had to touch all aspects of OR staff
 - Equipment managers on setup in room
 - Central sterile upgrade for instrument cleaning + sterilization
 - OR RNs + STs on new instrumentation + sets
 - New camera, robotic instruments, drapes and supplies

Training – Interprofessional Team



- Reducing OR setup time
 - Inservice of all staff on new technology
 - Hands on training instruments + draping
 - Standardization of setup
 - Disposable supplies stocked in central area
 - Standard sets used for every case
- Discussion of case order
 - Meeting/call with surgeon, anesthesia providers, OR staff prior to case to discuss order of events

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Oncologic Outcomes



Long-term Functional and Oncologic Results of Transoral Robotic Surgery for Oropharyngeal Squamous Cell Carcinoma

Eric J. Moore, MD; Steven M. Olsen, MD; Rebecca R. Laborde, PhD;
Joaquín J. García, MD; Francis J. Walsh, BA; Daniel L. Price, MD; Jeffrey R. Janus, MD;
Jan L. Kasperbauer, MD; and Kerry D. Olsen, MD

- Prospectively monitored TORS database
 - 66 patients
 - Minimum 24 months follow-up (mean 36 months)
- Outcomes
 - Disease – Specific
 - Recurrence Free Survival

TABLE 2. AJCC Clinical T Stage, Pathologic T Stage, Pathologic N Stage, and Pathologic Overall Stage of 66 Patients Who Underwent Transoral Robotic Surgery for Oropharyngeal Squamous Cell Carcinoma^a

Stage	No. (%)
Pathologic overall stage	
I	3 (4.5)
II	5 (7.6)
III	7 (10.6)
IVA	43 (65.2)
IVB	8 (12.1)

Oncologic Outcomes



TABLE 5. Kaplan-Meier Estimates of 3-Year Disease-Specific and Recurrence-Free Survival Stratified by Tobacco Use and Human Papillomavirus Status in 66 Patients Who Underwent Transoral Robotic Surgery for Oropharyngeal Squamous Cell Carcinoma

Risk factor	Disease-specific 3-year survival		Recurrence-free 3-year survival	
	No. (%)	P value	No. (%)	P value
Tobacco use		.59		.36
Nonsmoker (n=51)	51 (95.6)		51 (94.1)	
Smoker (n=15)	15 (93.3)		15 (86.7)	
HPV		.08		.08
HPV-positive (n=48)	48 (97.8)		48 (96.0)	
HPV-negative (n=18)	18 (88.9)		18 (83.3)	
Tobacco use and HPV		.34		.29
Nonsmoker and HPV-positive (n=40)	40 (96.7)		40 (95.0)	
Smoker and HPV-negative or HPV-positive (n=26)	26 (92.3)		26 (88.5)	

HPV = human papillomavirus.

Moore, E. J. et al. (2012). Long-term functional and oncologic results of transoral robotic surgery for oropharyngeal squamous cell carcinoma. *Mayo Clinic Proceedings*

Functional Outcomes



Survival and Gastrostomy Prevalence in Patients With Oropharyngeal Cancer Treated With Transoral Robotic Surgery vs Chemoradiotherapy

Arun Sharma, MD, MS; Sapna Patel, MD; Fred M. Baik, MD; Grant Mathison, MD; Brendan H. G. Pierce, MD; Samir S. Khariwala, MD, MS; Bevan Yueh, MD, MPH; Stephen M. Schwartz, MPH, PhD; Eduardo Méndez, MD, MS

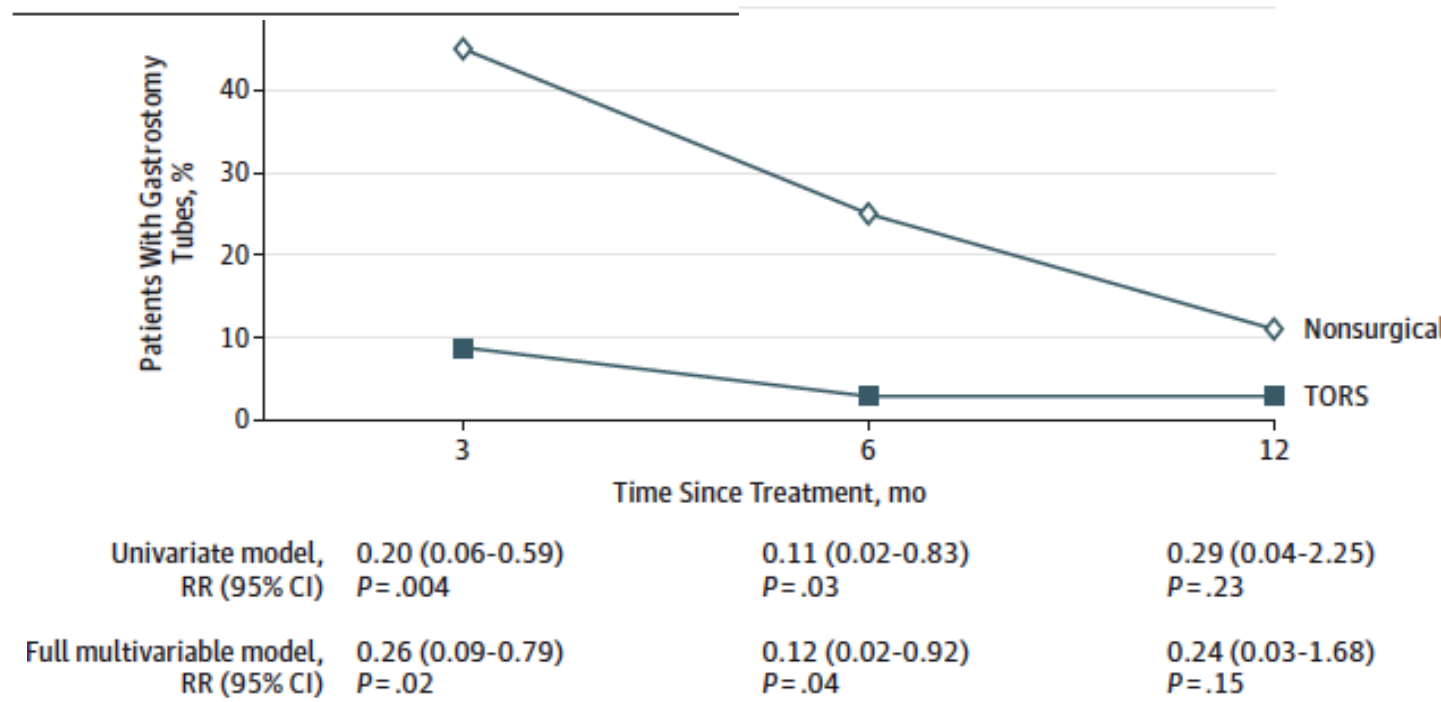
- Multi-institutional, retrospective matched cohort study
 - 127 patients
- Outcomes:
 - DSS & OSS
 - Gastrostomy tube rate

Characteristic	Treatment Group, No. (%) of Patients ^a	
	Nonsurgical (n = 88)	TORS (n = 39)
Tumor T stage		
1	22 (25.0)	16 (41.0)
2	51 (58.0)	18 (46.2)
3	15 (17.0)	5 (12.8)
4	0	0
Tumor N stage		
0	7 (8.0)	5 (12.8)
1	8 (9.1)	7 (17.9)
2	64 (72.7)	24 (61.5)
3	9 (10.2)	3 (7.7)

Functional Outcomes



Figure 3. Gastrostomy Tube Prevalence Over Time



Conclusions

This study provides evidence among T stage-matched patients that the use of TORS-based therapy for OPSCC could yield **improvements in swallowing while offering survival outcomes that are comparable to those with nonsurgical therapy.**

Outline



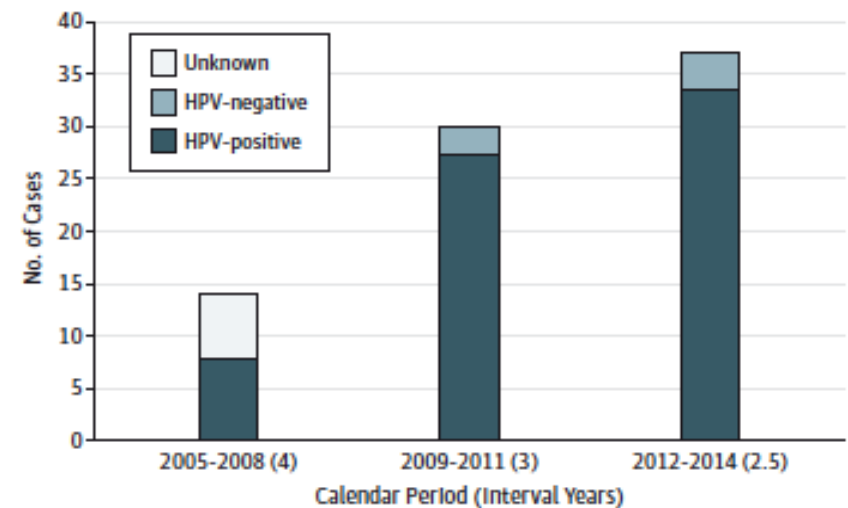
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Future Directions



- *How can we utilize this robotic technology to treat other diseases in a new way?*
- Increasing incidence of head and neck carcinoma unknown primaries
- Vast majority (90.7%) are HPV-associated squamous cell carcinoma

Figure 3. Human Papillomavirus (HPV) Tumor Status Among Unknown Primary Squamous Cell Carcinoma of the Head and Neck at Presentation Over Time



The proportion of unknown primary squamous cell carcinomas of the head and neck that were HPV-positive was similar across calendar periods (100% in 2005-2008, 90.3% in 2009-2011, and 89.7% in 2012-2014; $P = .64$).

Carcinoma of Unknown Primary



Diagnostic Evaluation of Squamous Cell Carcinoma Metastatic to Cervical Lymph Nodes From an Unknown Head and Neck Primary Site

Marco Cianchetti, MD; Anthony A. Mancuso, MD; Robert J. Amdur, MD; John W. Werning, MD; Jessica Kirwan, MA; Christopher G. Morris, MS; William M. Mendenhall, MD

- Tonsil fossa and base of tongue are the most common site to harbor CUP
 - 90% of mucosal lesions identified in the oropharynx

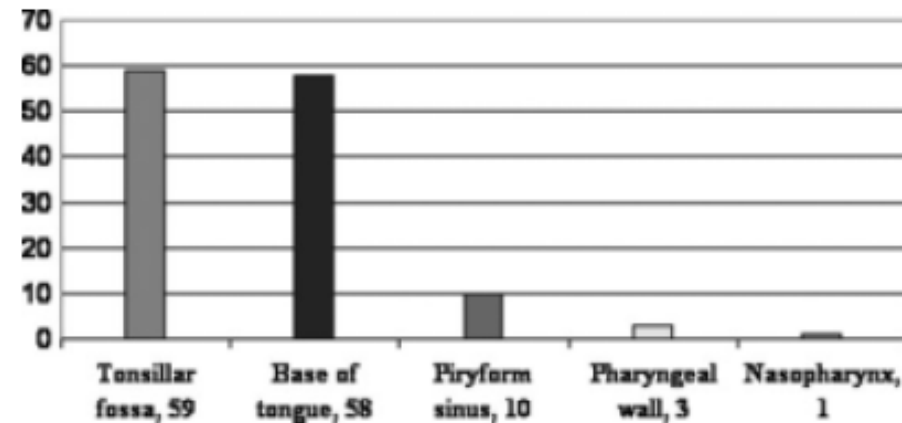
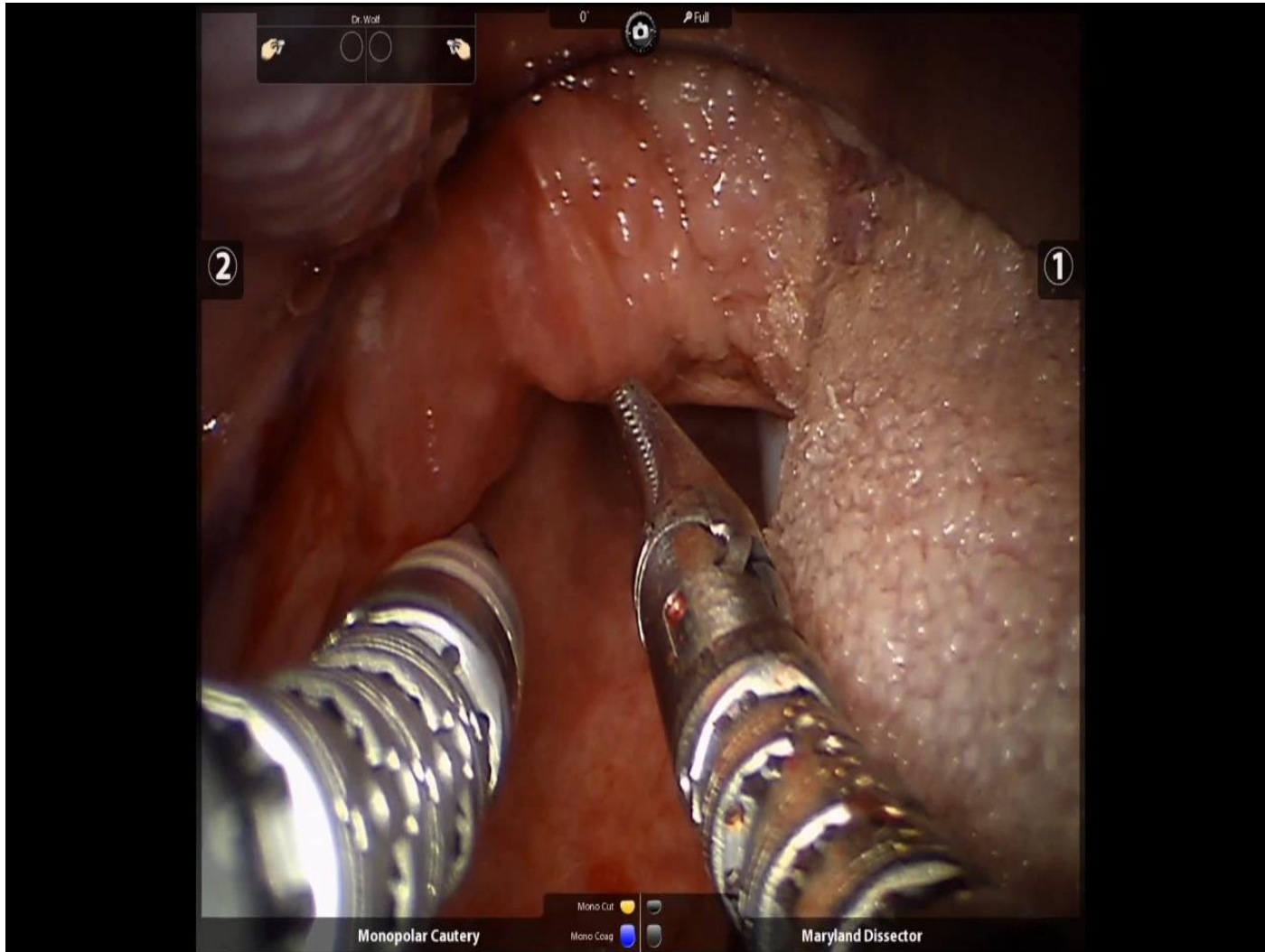
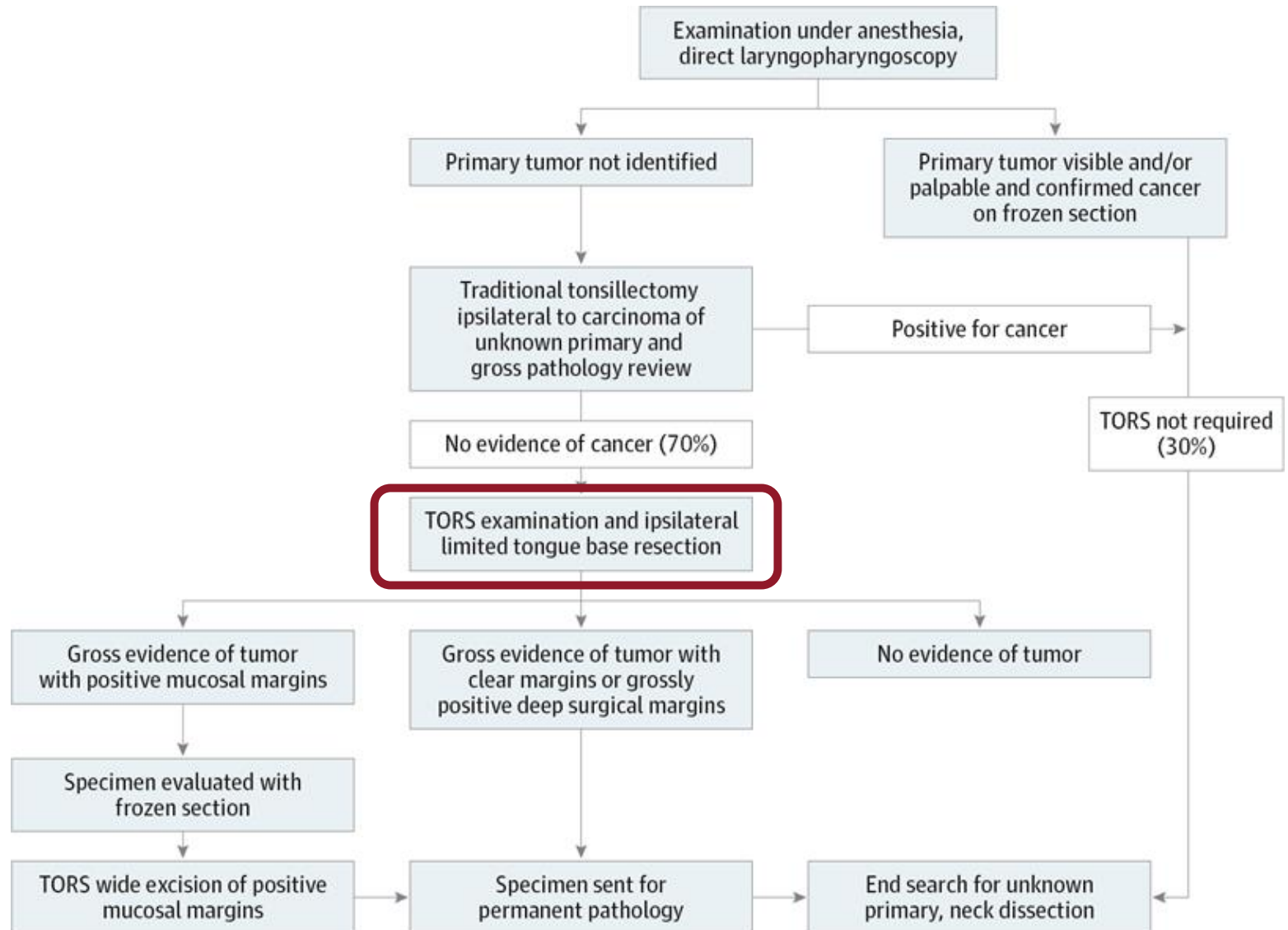


Fig. 1. Site distribution of primary lesions detected.

Carcinoma of Unknown Primary



CUP – Developing new algorithms



Resurgence of Surgery



Increasing primary surgical treatment of T1 and T2 Oropharyngeal Squamous Cell Carcinoma and rates of adverse pathologic features; NCDB

Jennifer R. Craccholo, M.D.¹, Shrujal S. Baxi, M.D., M.P.H.^{1,2}, Luc G. Morris, M.D., M.Sc.¹, Ian Ganly, M.D., M.Sc., PhD.¹, Snehal G. Patel, M.D.¹, Marc A. Cohen, M.D., M.P.H.^{1,2}, and Benjamin R. Roman, M.D., M.S.H.P.¹

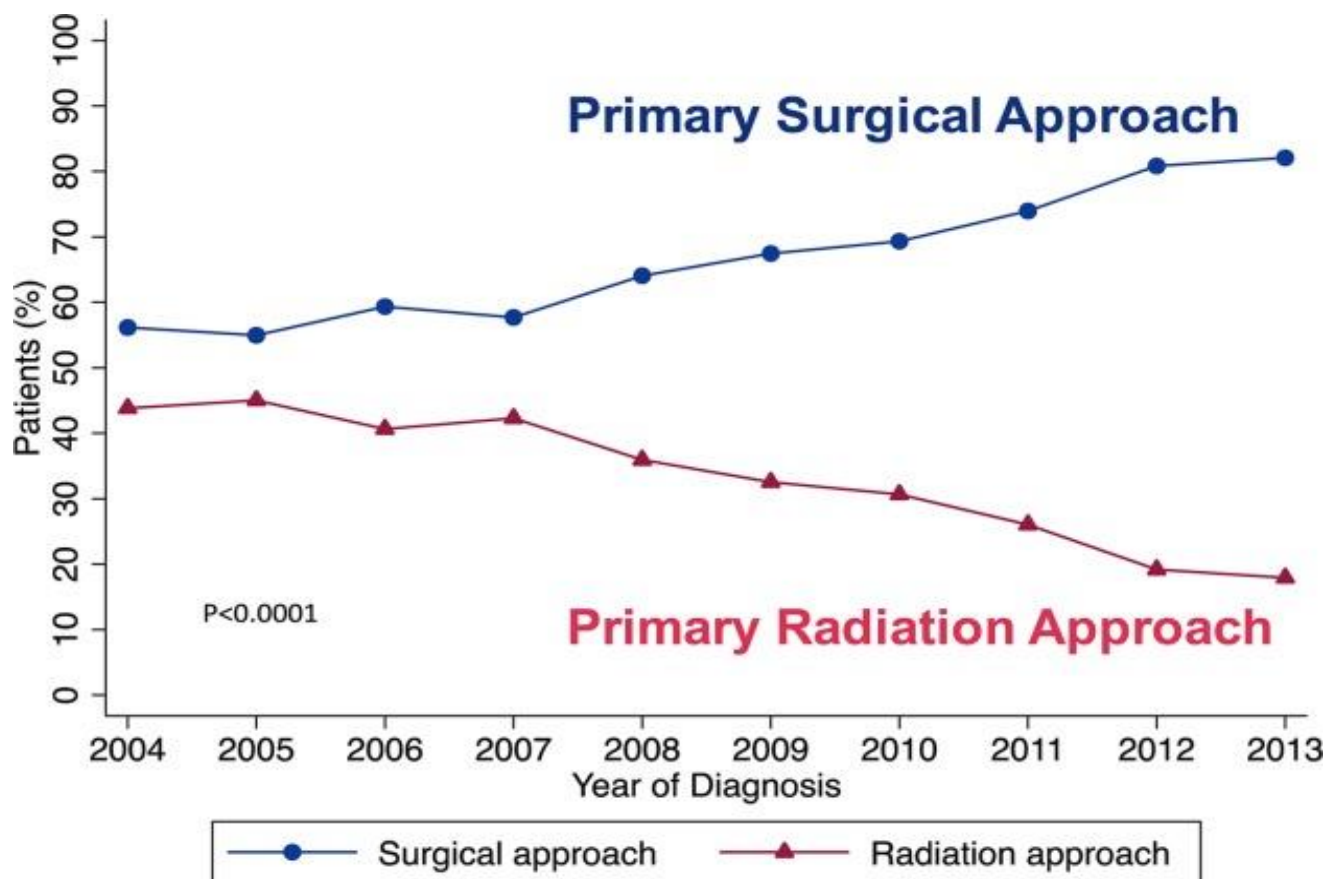
¹Memorial Sloan Kettering Cancer Center

- Cancer database identified oropharyngeal cancer pathology management has evolved from 2004-2013
 - Primary surgical treatment has increased in early-stage oropharyngeal cancer:
 - 56% in 2004 → 82% in 2013

Resurgence of Surgery



Increasing primary surgical treatment of T1 and T2 Oropharyngeal Squamous Cell Carcinoma and rates of adverse pathologic features; NCDB



Conclusions



- TORS is safe and effective at minimally invasive approach to oropharynx
- Functional outcomes show improved swallowing performance and reduced feeding tube dependence
- Future directions:
 - Utilizing robotic instrumentation to identify occult malignancies

References



- Chen, A et al. (2007). Changes in treatment of advanced oropharyngeal cancer, 1985-2001. *The Laryngoscope*, 117(1), 16–21.
- Chen, A et al. (2014). Temporal trends in oropharyngeal cancer treatment and survival: 1998-2009. *The Laryngoscope*, 124(1), 131–138.
- Forastiere, A et al. (1999). Radiotherapy and concurrent chemotherapy: a strategy that improves locoregional control and survival in oropharyngeal cancer. *Journal of the National Cancer Institute*, 91(24), 2065–2066.
- Fu, T et al (2016). The role of transoral robotic surgery, transoral laser microsurgery, and lingual tonsillectomy in the identification of head and neck squamous cell carcinoma of unknown primary origin: a systematic review. *Journal of Otolaryngology - Head & Neck Surgery*
- Hockstein, N. G., Malley, B. W. O., & Weinstein, G. S. (2006). Assessment of Intraoperative Safety in Transoral Robotic Surgery. *The Laryngoscope*, 116(2), 165–168. <http://doi.org/10.1097/01.mlg.0000199899.00479.75>
- Hockstein, N. G., Nolan, J. P., O'Malley, B. W., & Woo, Y. J. (2005). Robot-assisted pharyngeal and laryngeal microsurgery: results of robotic cadaver dissections. *The Laryngoscope*, 115(6), 1003–1008.
- Moore, E. J., Olsen, K. D., & Kasperbauer, J. L. (2009). Transoral robotic surgery for oropharyngeal squamous cell carcinoma: A prospective study of feasibility and functional outcomes. *The Laryngoscope*, 119(11), 2156–2164.
- Moore, E. J., Olsen, S. M., Laborde, R. R., García, J. J., Walsh, F. J., Price, D. L., et al. (2012). Long-term functional and oncologic results of transoral robotic surgery for oropharyngeal squamous cell carcinoma. *Mayo Clinic Proceedings*, 87(3), 219–225.
- More, Y. I., Tsue, T. T., Girod, D. A., Harbison, J., Sykes, K. J., Williams, C., & Shnyder, Y. (2013). Functional swallowing outcomes following transoral robotic surgery vs primary chemoradiotherapy in patients with advanced-stage oropharynx and supraglottis cancers. *JAMA Otolaryngology–Head & Neck Surgery*, 139(1), 43–48.
- O'Malley, B. W., Weinstein, G. S., Snyder, W., & Hockstein, N. G. (2006). Transoral robotic surgery (TORS) for base of tongue neoplasms. *The Laryngoscope*, 116(8), 1465–1472.
- Sharma, A, et al. (2016). Survival and Gastrostomy Prevalence in Patients With Oropharyngeal Cancer Treated With Transoral Robotic Surgery vs Chemoradiotherapy. *JAMA Otolaryngology–Head & Neck Surgery*, 142(7), 691–697.
- Sturgis, E. M., & Cinciripini, P. M. (2007). Trends in head and neck cancer incidence in relation to smoking prevalence - An emerging epidemic of human papillomavirus-associated cancers? *Cancer*, 110(7), 1429–1435.
- White, H et al. (2013). Salvage surgery for recurrent cancers of the oropharynx: comparing TORS with standard open surgical approaches. *JAMA Otolaryngology–Head & Neck Surgery*, 139(8), 773–778.
- Cianchetti, M. et al (2009). Diagnostic evaluation of squamous cell carcinoma metastatic to cervical lymph nodes from an unknown head and neck primary site. *The Laryngoscope*, 119(12), 2348–2354.
- Keller, L. M. et al. (2014). p16 status, pathologic and clinical characteristics, biomolecular signature, and long-term outcomes in head and neck squamous cell carcinomas of unknown primary. *Head & Neck*, 36(12), 1677–1684.