Singapore General Hospital
SingHealth

Transoral robotic Surgery in the era of HPV epidemic

Dr Lim Chwee Ming

MBBS, MRCS(Edin), MMed (ORL)
Senior Consultant
Department of Otolaryngology
Singapore General Hospital
Duke-NUS Graduate Medical School

iota medtech

Enhancing Surgery Through Robotics

Disclosures

PCT PATENTS

TECHNOLOGY DEVELOPMENT AGREEMENTS

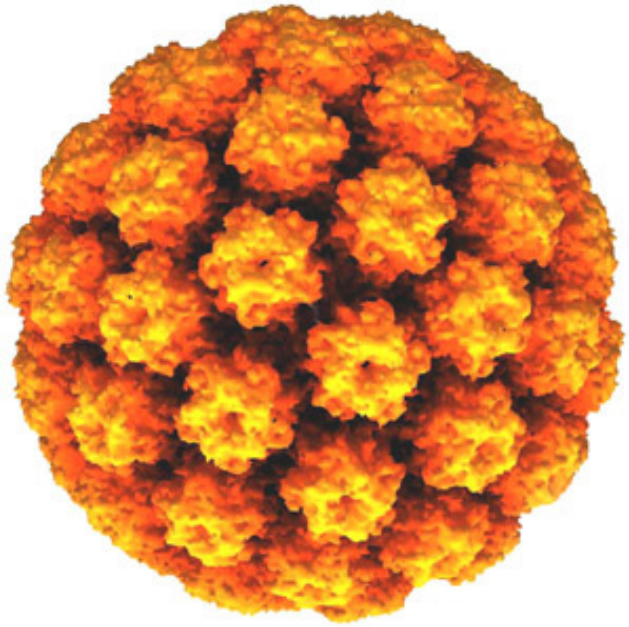
IN-PART BY NMRC B & B

Outline

- 1. Background of OPSCC – new epidemic
- 2. TORS in oropharyngeal cancer –new paradigm in surgical treatment
- 3. Future advances in robotic technology

Oropharyngeal squamous cell cancer (OPSCC)

- HPV associated OPSCC has reached epidemic proportion in Western countries
- Distinct biology compared with HPV negative cohort
- Portends a better prognosis -
- ?Role of de-escalation of treatment



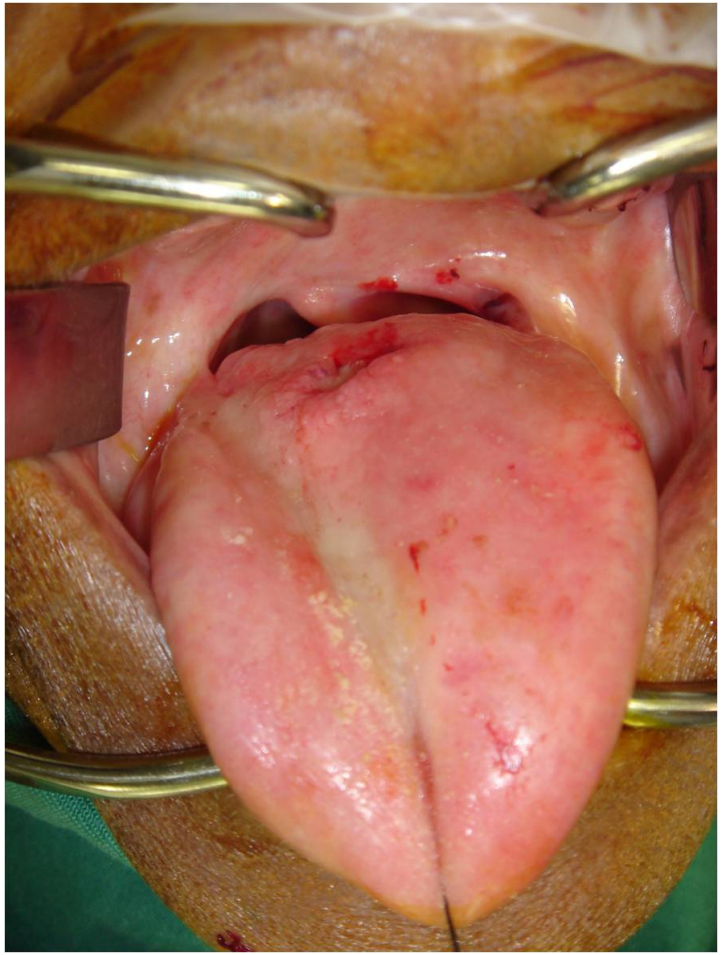
OPSCC

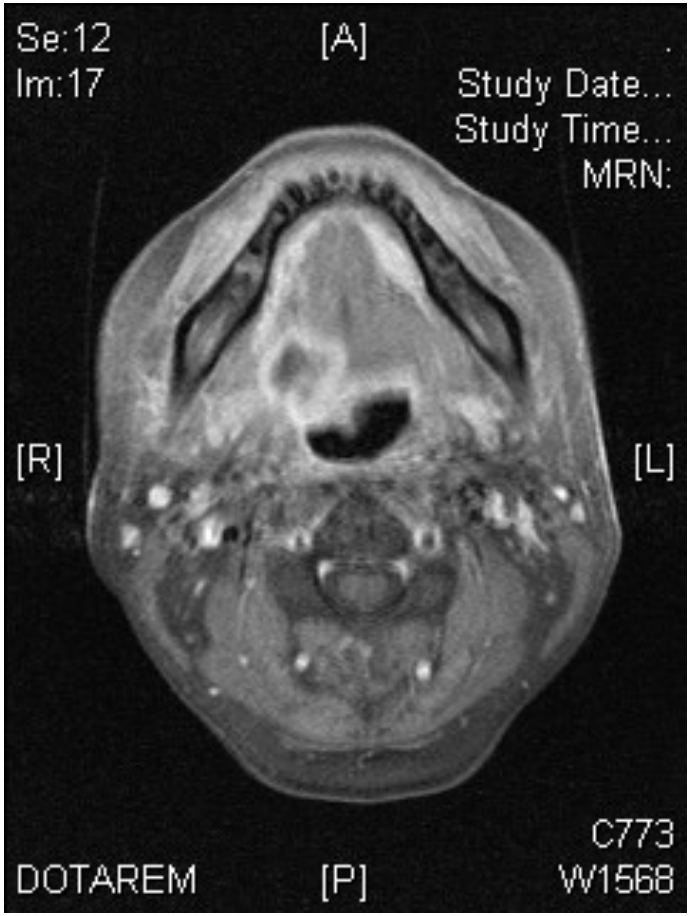
	HPV Positive	HPV Negative
Demographics	Younger (<60 years) Higher Socioeconomic status	Older (>60 years) Lower socioeconomic status
Risk factors	Sexual behaviour	Smoking cigarette Chronic alcohol consumption
Histopathology	Basaloid features, poorly differentiated SCC	Keratinizing SCC
Incidence	Increasing	Decreasing
Clinical features	Small tumor (T1-2), larger nodal metastasis (usually cystic nodes)	Variable
Biology	TP53 wild type, low EGFR	TP53 mutant, high EGFR
Prognosis	Good	Poor

OPSCC

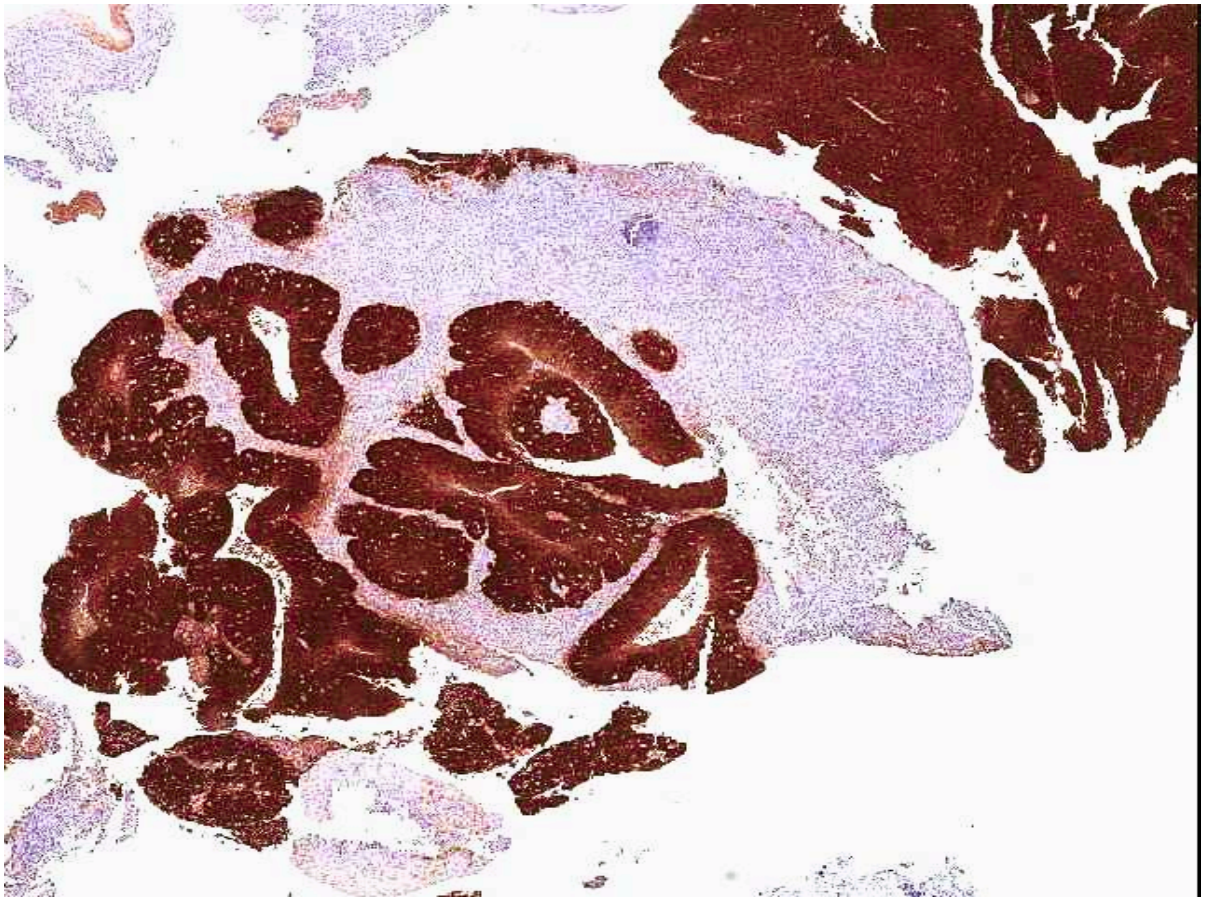
	HPV Positive	HPV Negative
Demographics	Younger (<60 years) Higher Socioeconomic status	Older (>60 years) Lower socioeconomic status
Risk factors	Sexual behaviour	Smoking cigarette Chronic alcohol consumption
Histopathology	Basaloid features, poorly differentiated SCC	Keratinizing SCC
Incidence	Increasing	Decreasing
Clinical features	Small tumor (T1-2), larger nodal metastasis (usually cystic nodes)	Variable
Biology	TP53 wild type, low EGFR	TP53 mutant, high EGFR
Prognosis	Good	Poor

42 year old lady



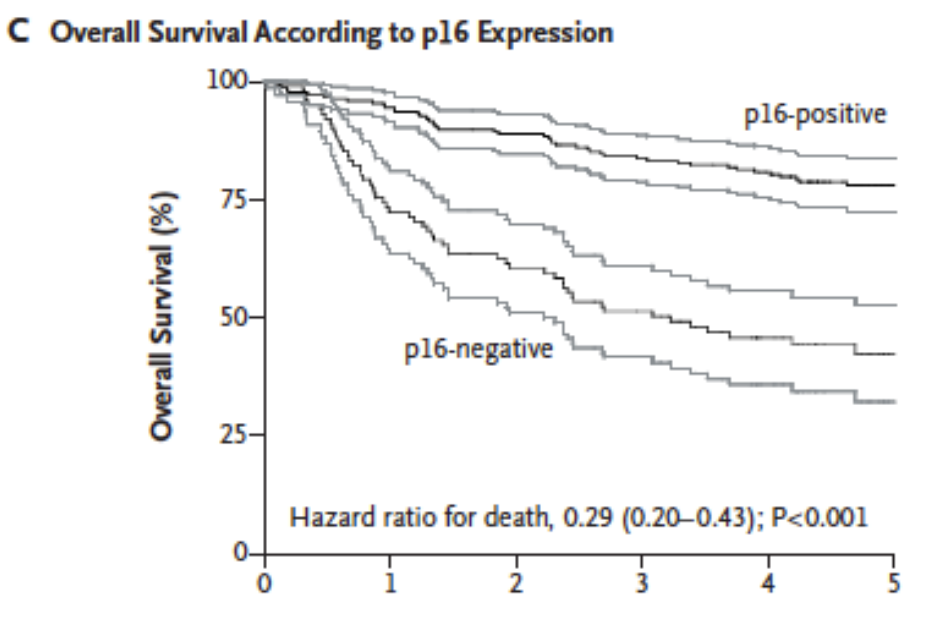


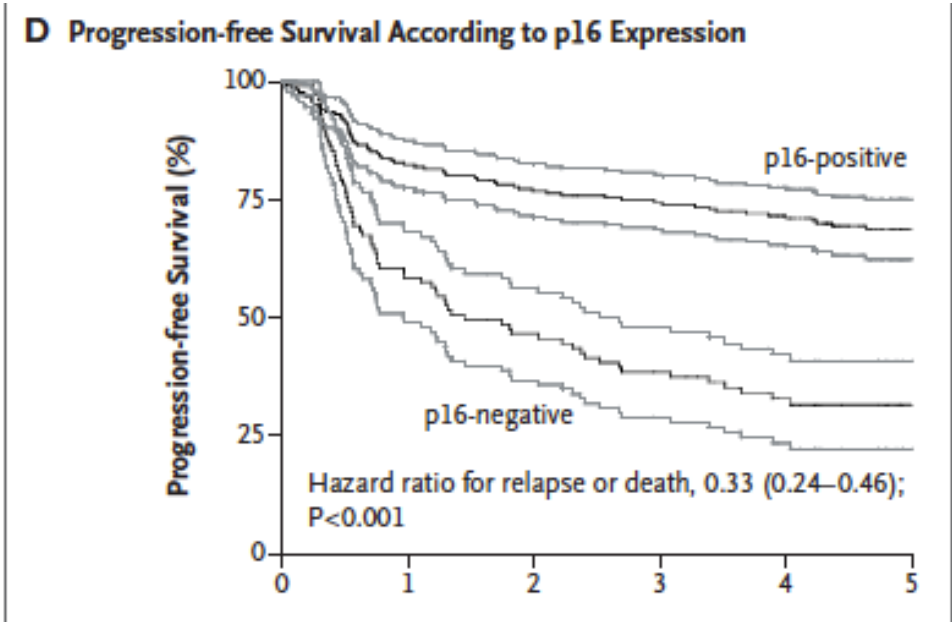
p16 IHC

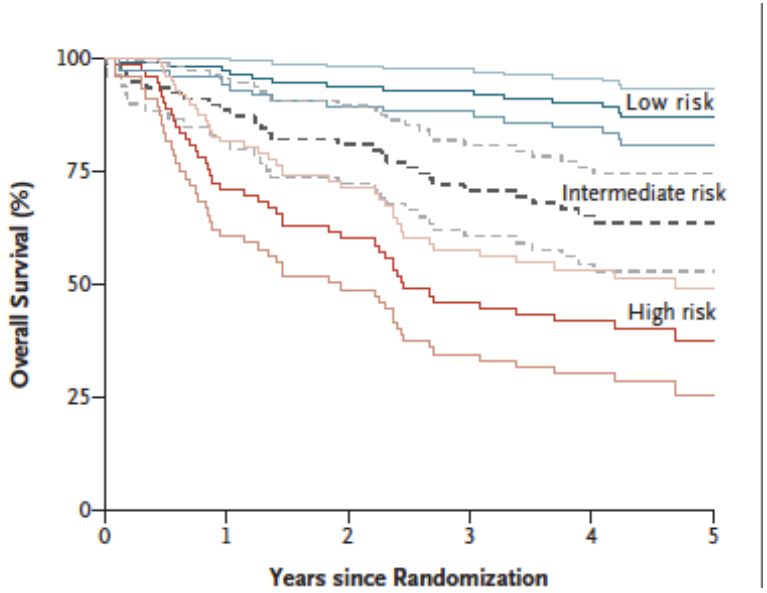


HPV induced OPSCC and Survival

Study	Study design	HPV detection method	Treatment	Results			
				HPV status	Tumour stage	Outcomes	
Fakhry et al, 2008	Prospective study within ECOG 2399 trial N = 96, 34 larynx 2 yr followup	In situ hybridisation and PCR	Induction chemo followed by chemoradiation	HPV+ - 38	Stage 3 - 11 Stage 4 - 27	OS - 95% PFS - 86%	
				HPV- - 58	Stage 3 - 23 Stage 4 - 35 p = 0.62	OS - 62% PFS - 53%	p = 0.02 p = 0.01
Ang et al, 2010	Retrospective analysis within RTOG 0129 study N = 323 3 yr followup	In situ hybridization	Accelerated vs standard fractionation RT with concurrent cisplatin	HPV+ - 206	Stage 3 - 25 Stage 4 - 181	OS - 82.4% PFS - 73.7 %	
				HPV- - 117	Stage 3 - 19 Stage 4 - 98 p = 0.30	OS - 57.1% PFS - 43.4%	p < 0.001 p < 0.001
Rischin et al, 2010	Retrospective analysis within TROG 02.02 trial N = 185 2 yr followup	p16	Chemoradiation with and without tirapazamine	HPV+ - 106	Stage 3 - 6 Stage 4 - 100	OS - 91% FFS - 87%	
				HPV- - 79	Stage 3 - 10 Stage 4 - 69 p = 0.12	OS - 74% FFS - 72%	p = 0.004 p = 0.003
Posner et al, 2011	Restrospective analysis within TAX 324 trial N = 111 5 yr followup	PCR	Induction chemo (TPF vs PF) followed by chemoradiation	HPV+ - 56	Stage 3 - 10 Stage 4 - 46	OS - 82% PFS - 78%	
				HPV- - 55	Stage 3 - 5 Stage 4 - 50 p = 0.27	OS - 35% PFS - 28%	p < 0.0001 p < 0.0001







Ang KK et al . NEJM July 2010

Legend :
Low risk : HPV +ve, < 10 packs/year cigarette
Intermediate risk : HPV+ve with N0-N2; or HPV-ve with <10 pack/year, T2-T3
High risk : HPV-ve, smoker , advanced T4

High-risk HPV genotypes and P16INK4a expression in a cohort of head and neck squamous cell carcinoma patients in Singapore

Louise Soo Yee Tan[1], Petersson Fredrik[2], Liang Ker[1], Feng Gang Yu[1], De Yun Wang[3], Boon Cher Goh[4], Kwok Seng Loh[1,3], Chwee Ming Lim[1,3]

[1]Department of Otolaryngology-Head and Neck Surgery, National University Health System Singapore, Singapore 119228

[2]Department of Pathology, National University Health System Singapore, Singapore 119228

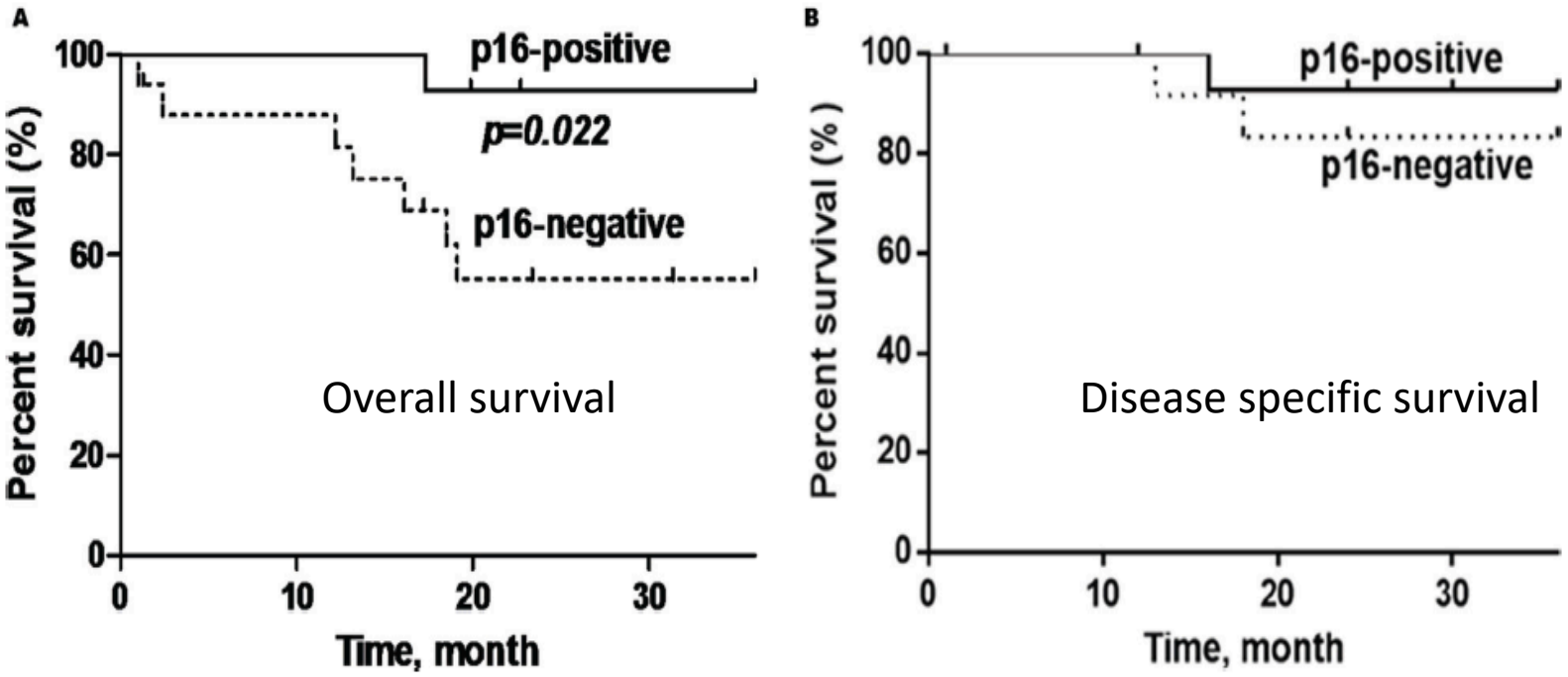
[3]Department of Otolaryngology, National University of Singapore, Singapore 119228

[4]Department of Medical Oncology, National University Health System Singapore, Singapore 119228

Correspondence to: Chwee Ming Lim, **email:** chwee_ming_lim@nuhs.edu.sg

Keywords: *human papillomavirus, p16 immunohistochemistry, HPV DNA, head and neck squamous cell carcinoma, oropharyngeal squamous cell carcinoma*

Received: *June 29, 2016* ***Accepted:*** *November 09, 2016* ***Published:*** *November 22, 2016*



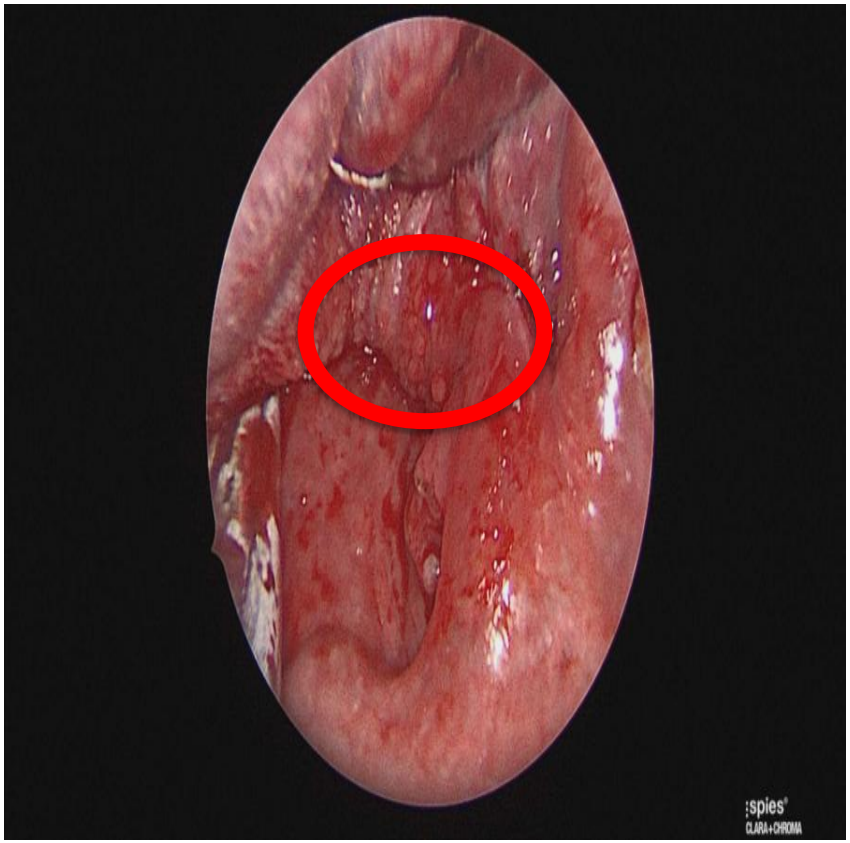
Oncotarget 2016 Dec, 7(52)

Rational of surgery in HPV positive OPSCC

- 1) Small primary – amendable for transoral resection
- 2) Younger cohort- minimize long term sides effects of RT
- 3) Aids accurate pathological assessment

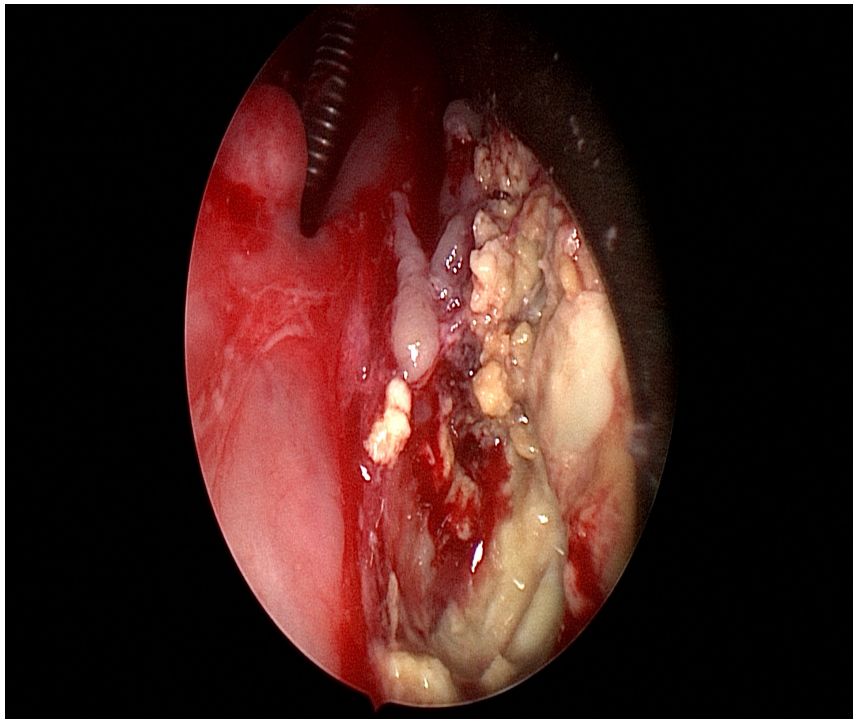
Emerging surgical trend in treating OPSCC

- Increased HPV induced OPSCC
- 1) Small primary – amendable for transoral resection

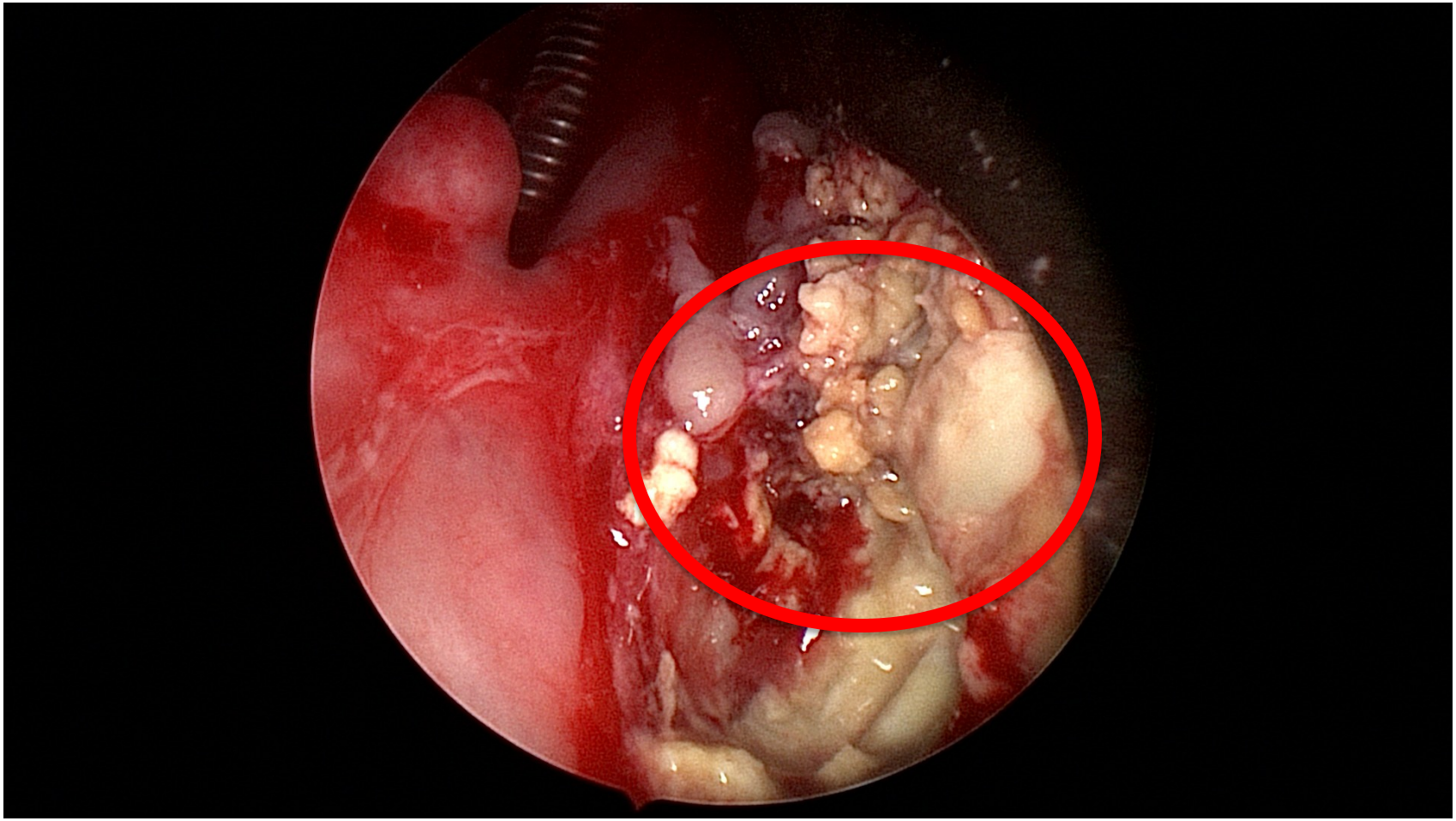


Emerging surgical trend in treating OPSCC

- 2) Younger cohort- minimize long term sides effects of RT



6 weeks post CRT for p16 +ve Rt Tonsillar Cancer



Emerging surgical trend in treating HPV positive OPSCC

- Aids accurate pathological assessment for possible

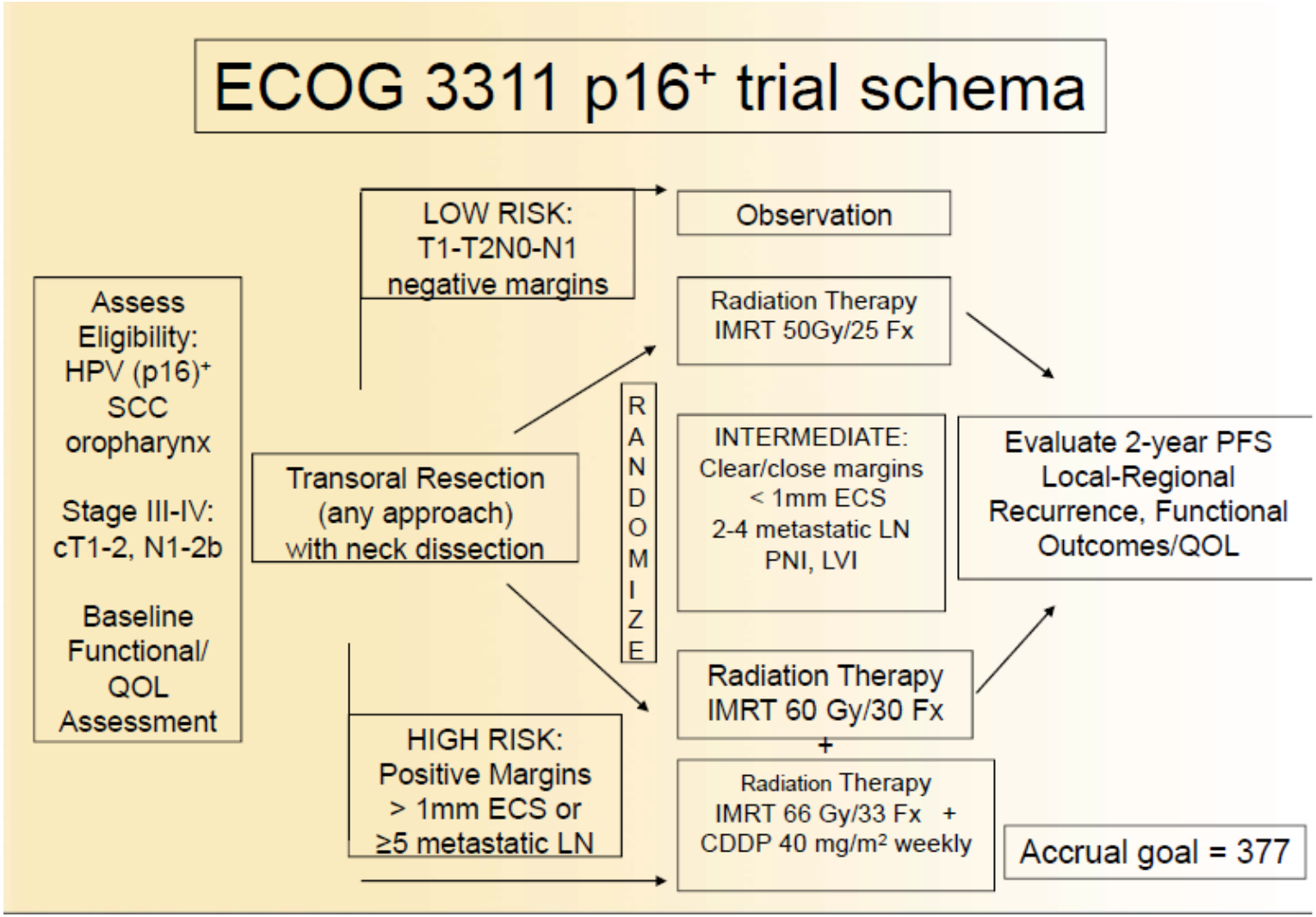
  De-escalation

Phase II Randomized Trial of Transoral Surgical Resection followed by Low-dose or Standard-dose IMRT in Resectable p16+ Locally Advanced Oropharynx Cancer (E3311)

PI : Bob Ferris

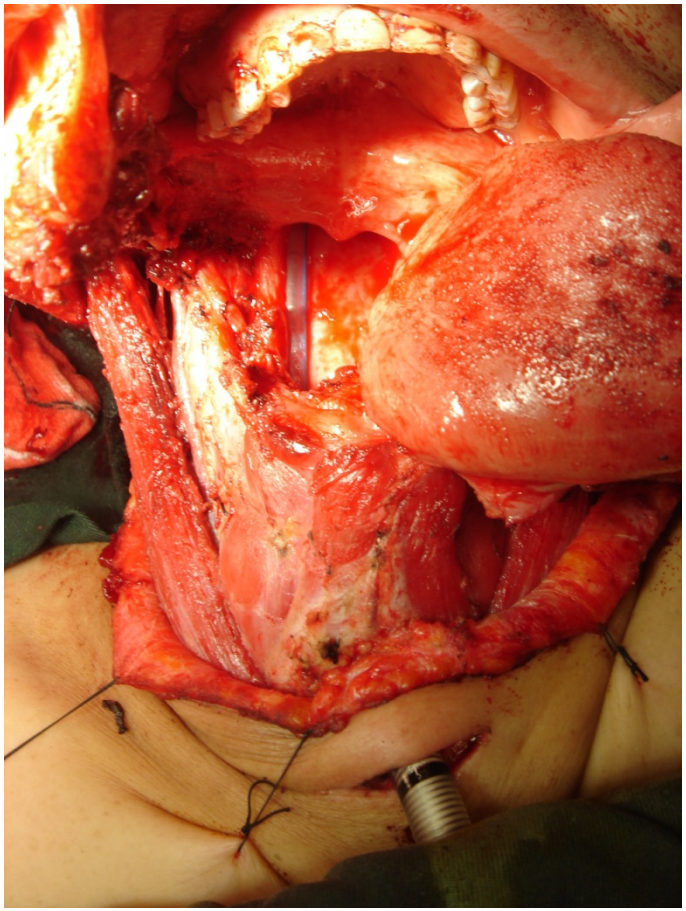
- p16+, Stage III/IV (cT1-2N1-N2b) OPSCC
- Credentialing of surgeon required as part of site participation in the trial
- Stratify by stage and smoking status

ECOG 3311 p16+ trial schema

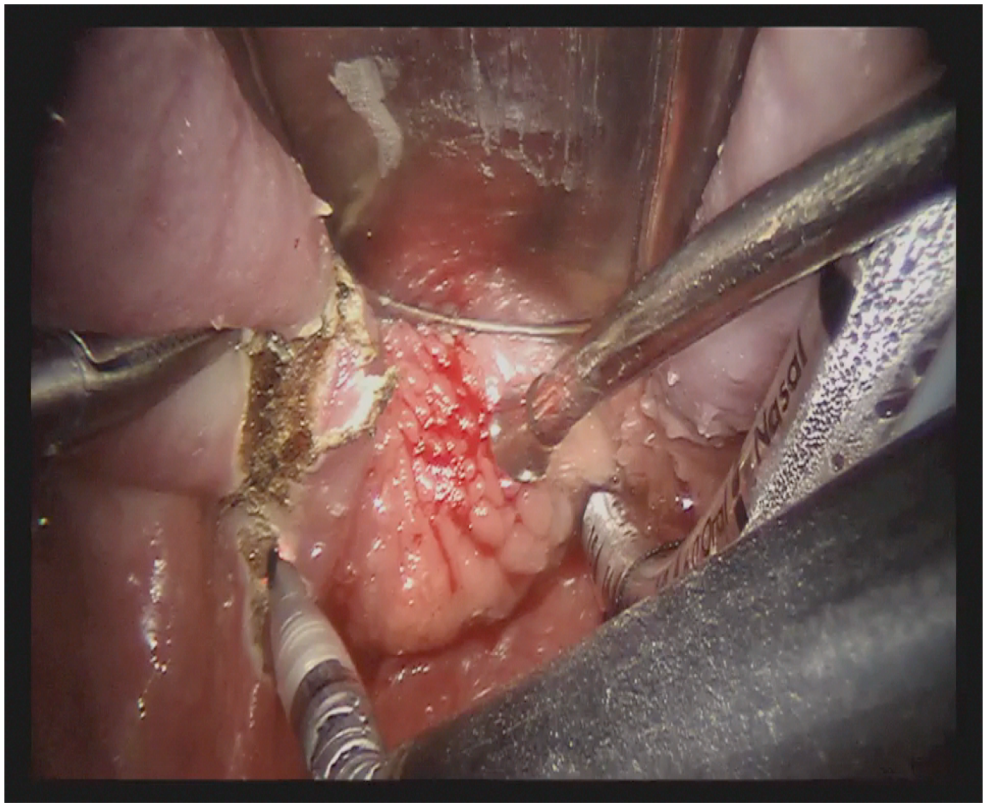


Traditional approach vs TORS in OPSCC

1980s to 2009



2009 till present

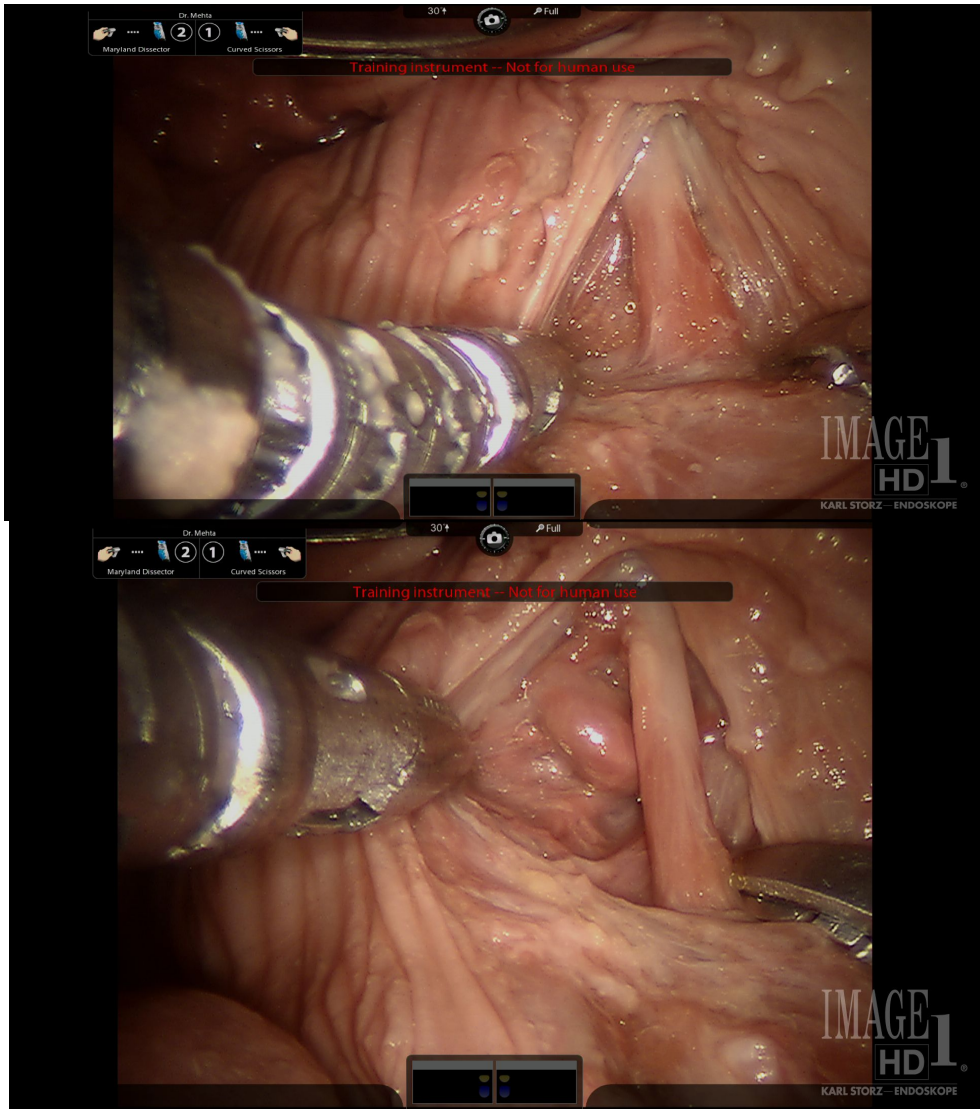


Starting a robotic head and neck surgery program

- 1) Re-learning anatomy - ”inside-out”
- 2) Building a team
- 3) Credentialing
- 4) Appropriate patient selection
- 5) Continuous education/ training and credentialing


da Vinci Si HD
SURGICAL SYSTEM
Taking Surgery Beyond the Limits of the Human Hand

- Anatomy is the road map for surgeons
- Re-learning the “inside-out” or “medial to lateral” approach



Transoral Anatomy of the Tonsillar Fossa and Lateral Pharyngeal Wall: Anatomic Dissection With Radiographic and Clinical Correlation

Chwee Ming Lim, MD; Vikas Mehta, MD; Raymond Chai, MD; Carlos-Neto D. Pinheiro, MD; Tanya Rath, MD; Carl Snyderman, MD, MBA; Umamahewswar Duvvuri, MD, PhD

Objectives/Hypothesis: To evaluate the transoral anatomy of the tonsillar fossa and lateral pharyngeal wall and to correlate these findings with radiographic measurements and transoral robotic surgery (TORS) of patients with early tonsillar tumor.

Study Design: Preclinical cadaveric study and patient cohort.

Methods: Six complete cadaveric dissections were performed to identify key anatomic landmarks, and these landmarks were validated in two consecutive patients with T1 human papillomavirus–positive squamous cell carcinoma of the tonsil treated by TORS. For radiographic landmark analysis, 25 patients who underwent contrast-enhanced computed tomography (CT) of the neck for a variety of endoscopic skull base procedures were selected. Measurements were taken from the lateral pharyngeal wall at C2-C3 interspace and greater horn of hyoid (C6) to the external carotid artery (ECA).

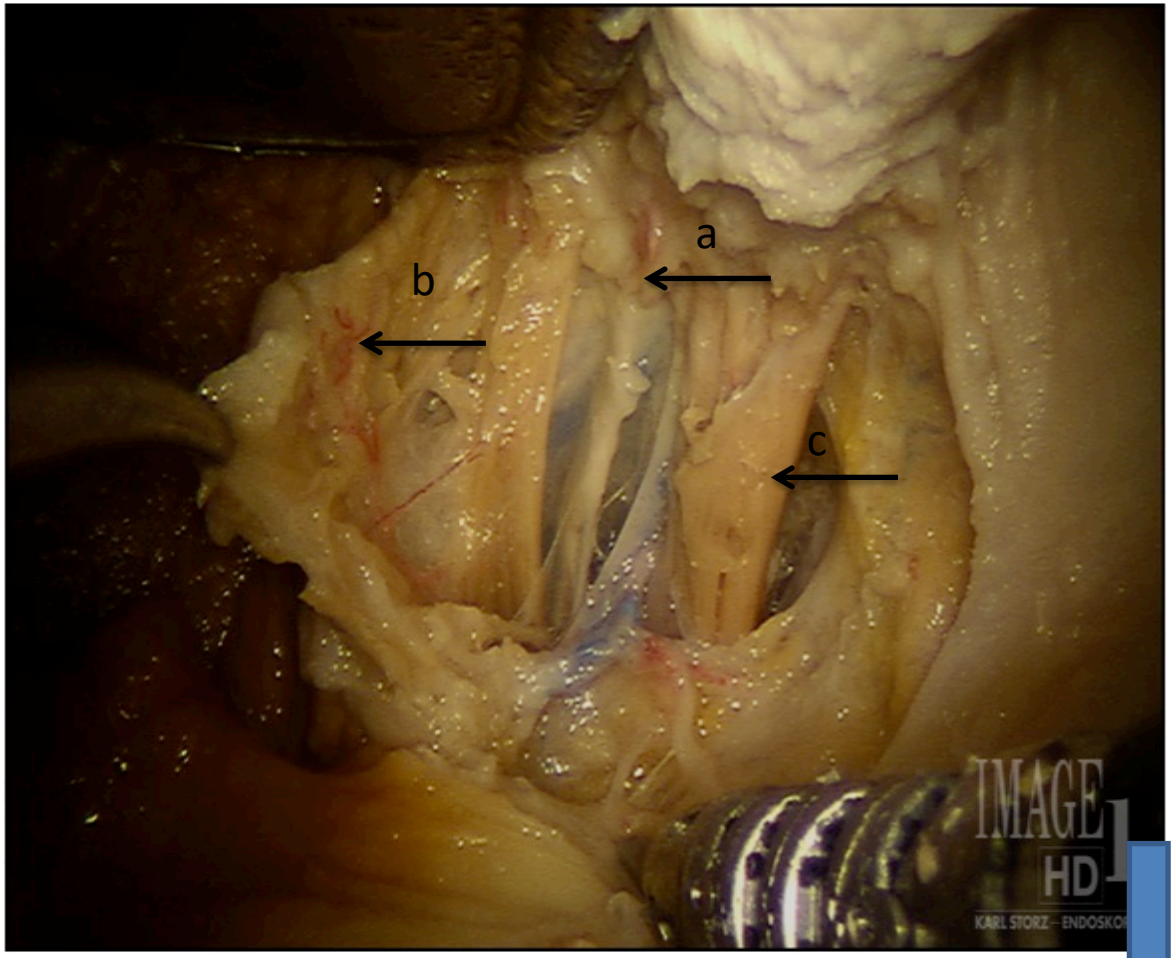
Results: The glossopharyngeal (IX) nerve was consistently identified deep to the superior constrictor musculature and at the intersection of the posterior tonsillar pillar with the base of tongue. The styloglossus muscle forms the deep plane medial to the ECA. The mean measurements for left C2-C3 interspace to the ECA and right C2-C3 interspace to ECA were 17.6 ± 0.8 mm and 18.4 ± 0.8 mm, respectively. Similarly, the mean measurements for left hyoid to ECA and right hyoid to ECA were 3.4 ± 0.8 mm and 4.3 ± 0.6 mm, respectively.

Conclusions: A systematic approach to dissect the tonsillar fossa and lateral pharyngeal wall can be performed using key anatomic landmarks. CT measurements taken at the C2-C3 interspace and greater horn of hyoid bone (C6 level) to the ECA are consistently and reliably achieved.

Key Words: Transoral robotic surgery, tonsillar fossa, lateral pharyngeal wall, anatomic dissection.

***Laryngoscope*, 00:000–000, 2012**

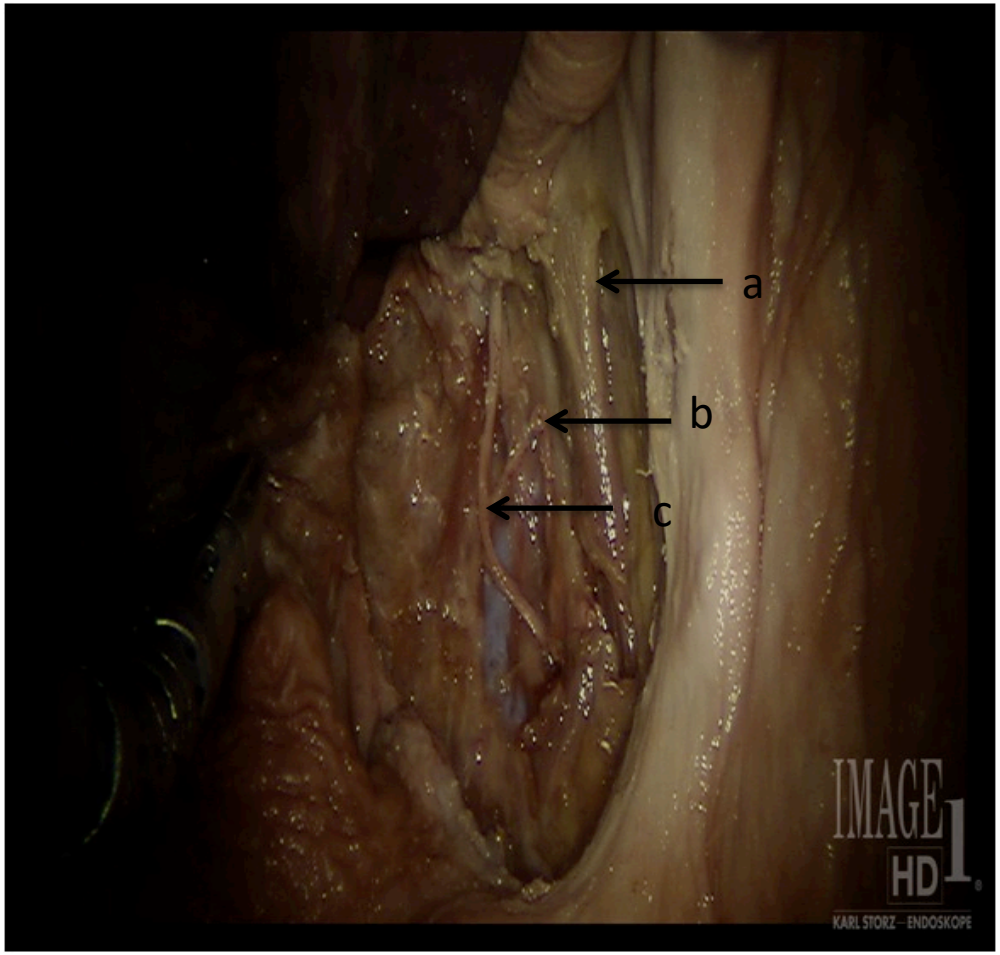
Consistent identification of main trunk of IX nerve



a) IX nerve
b) Superior constrictor
c) Styloglossus

IX nerve identified at intersection point of posterior tonsillar pillar and base of tongue after superior constrictor musculature transected and reflected medially

Branches of IX nerve

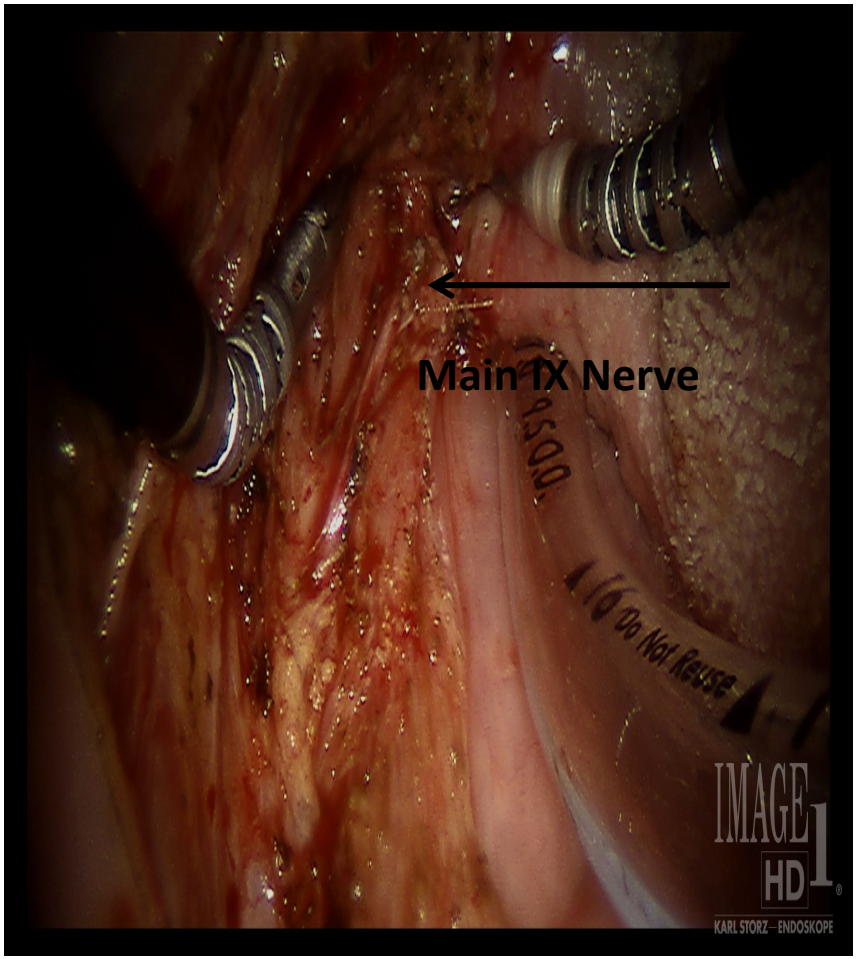


a) Styloglossus
b) Branch of IX nerve running towards lateral pharyngeal wall
c) Main IX nerve

Branches of IX nerve (after robotic radical tonsillectomy)

Head

Clinical correlation



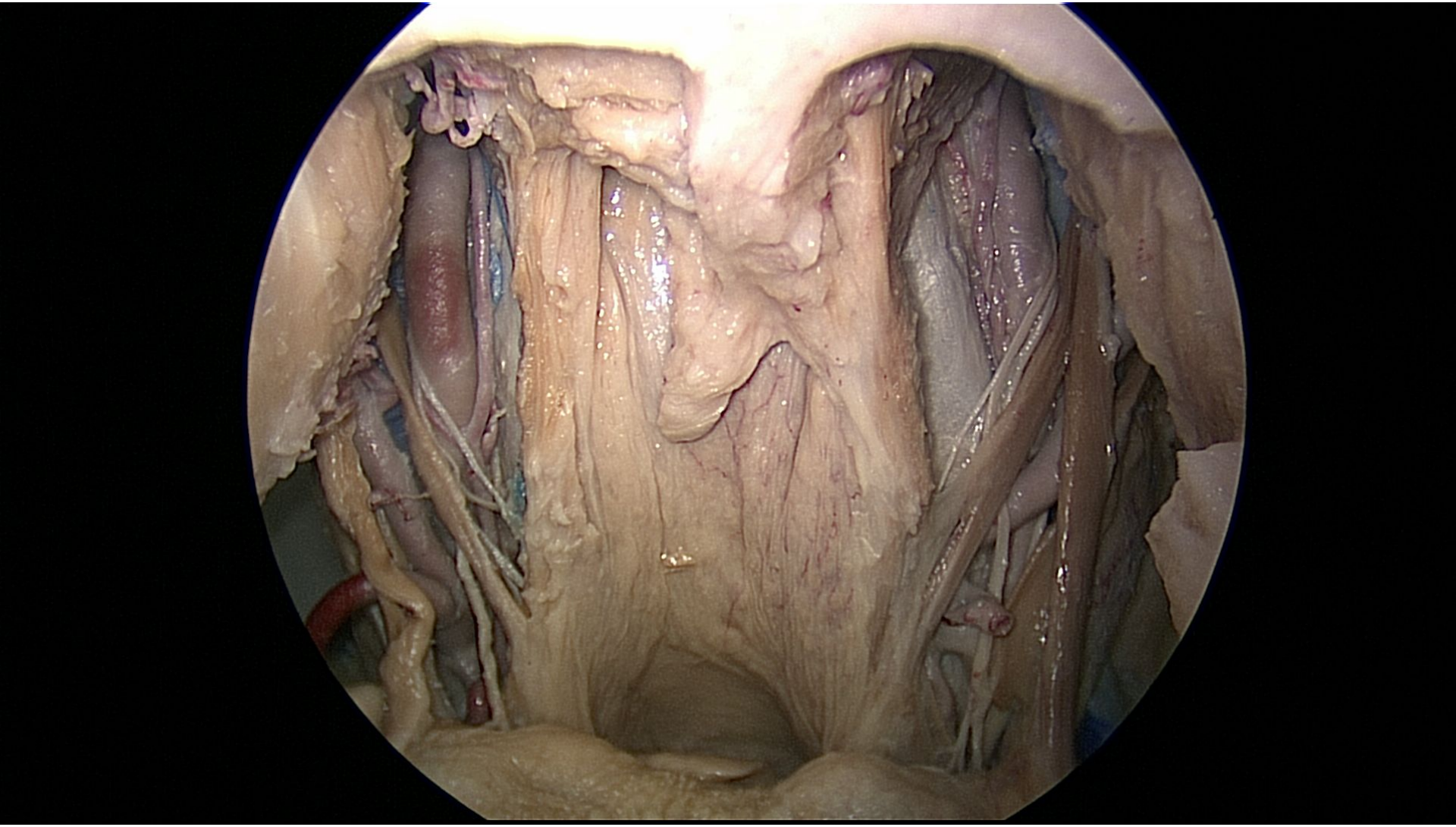
- Main trunk of IX preserved following TORS for T1 tonsil cancer

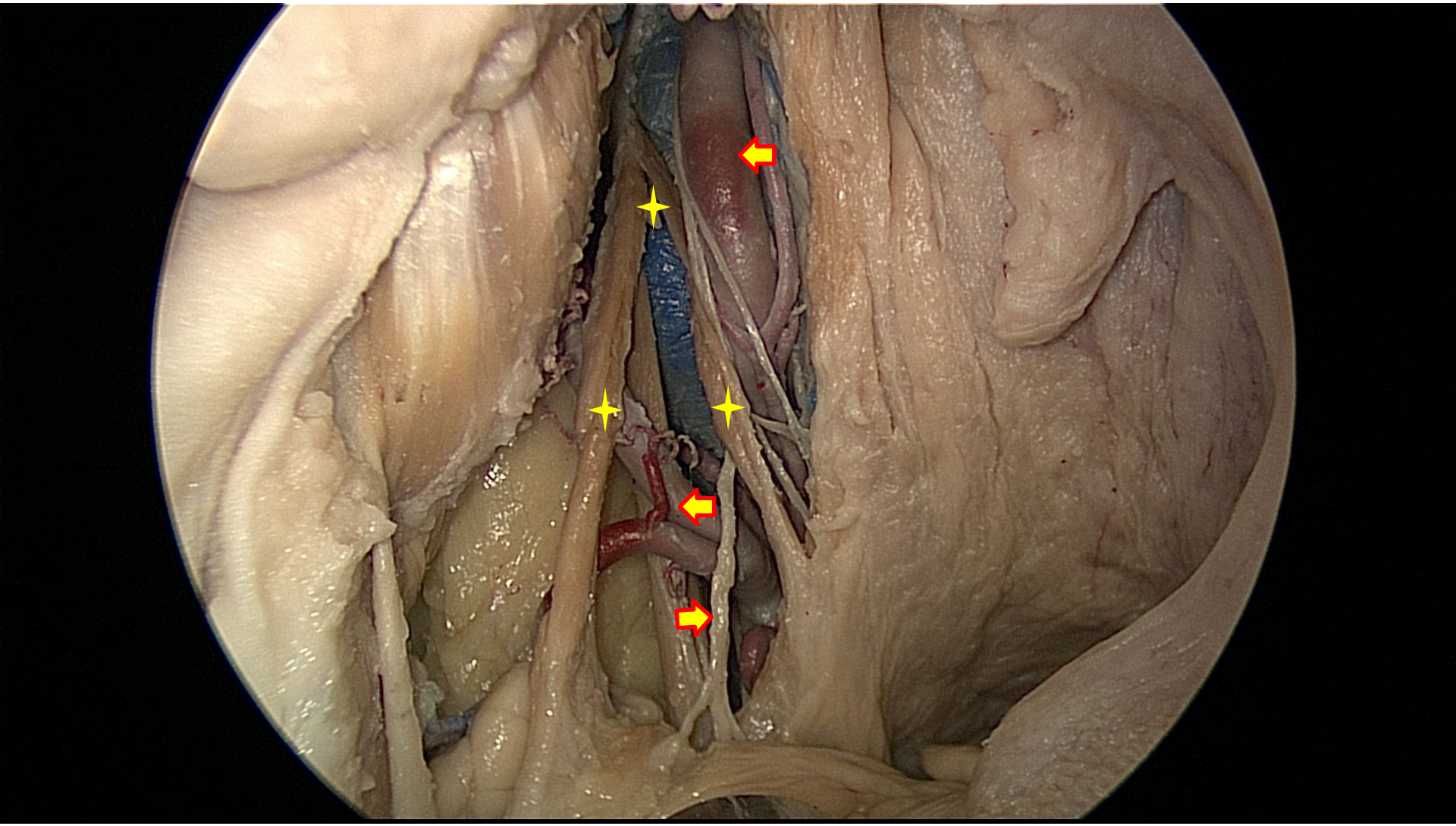
Head

中日友好医院
CHINA-JAPAN FRIENDSHIP HOSPITAL

- Prof Wang Cheng Yuan

- Visting Scholar UPMC
- 2012-2013





TORS Set up

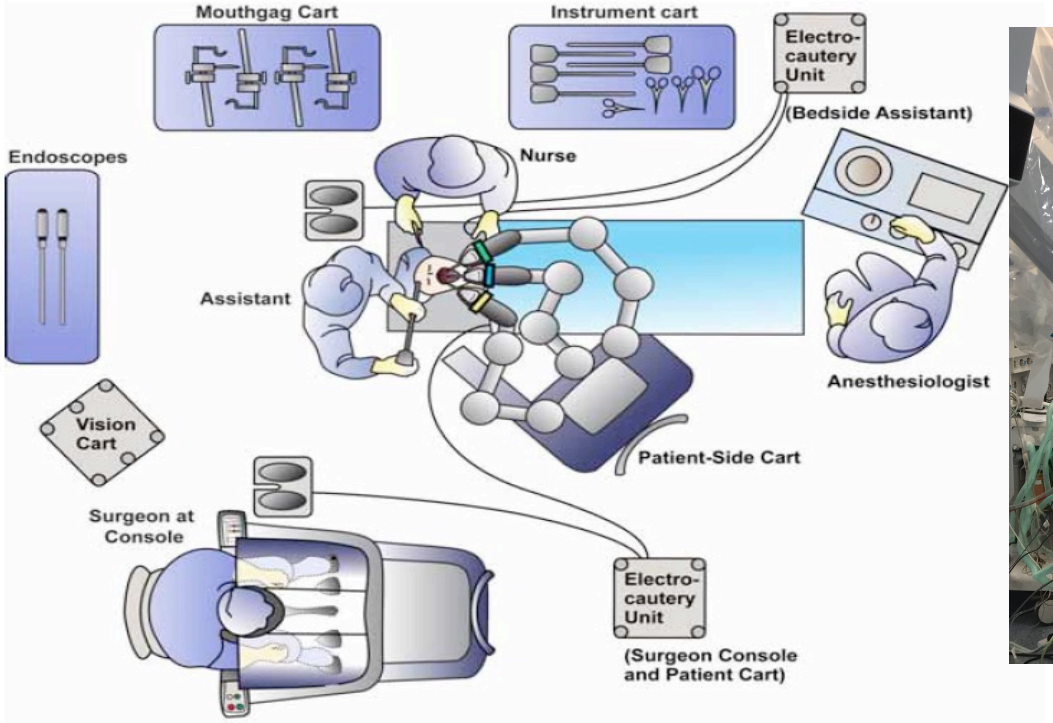
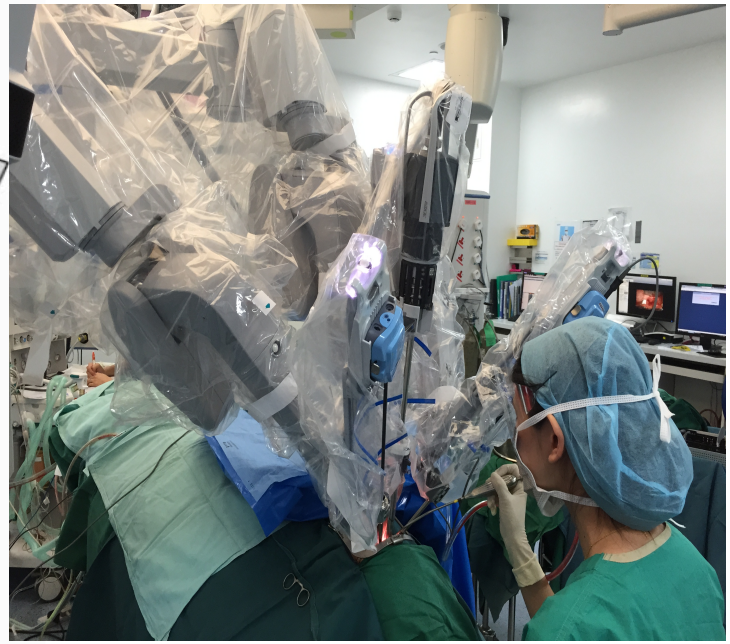
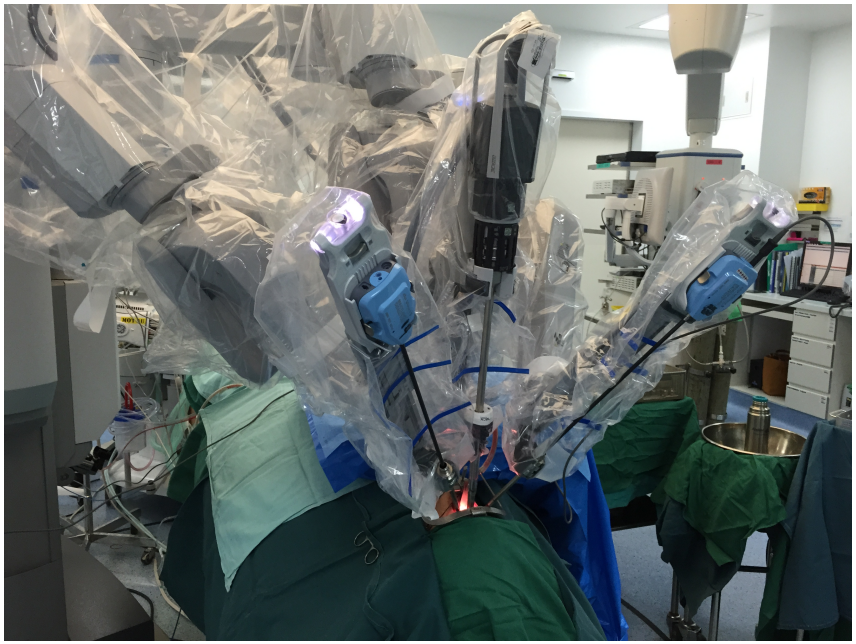
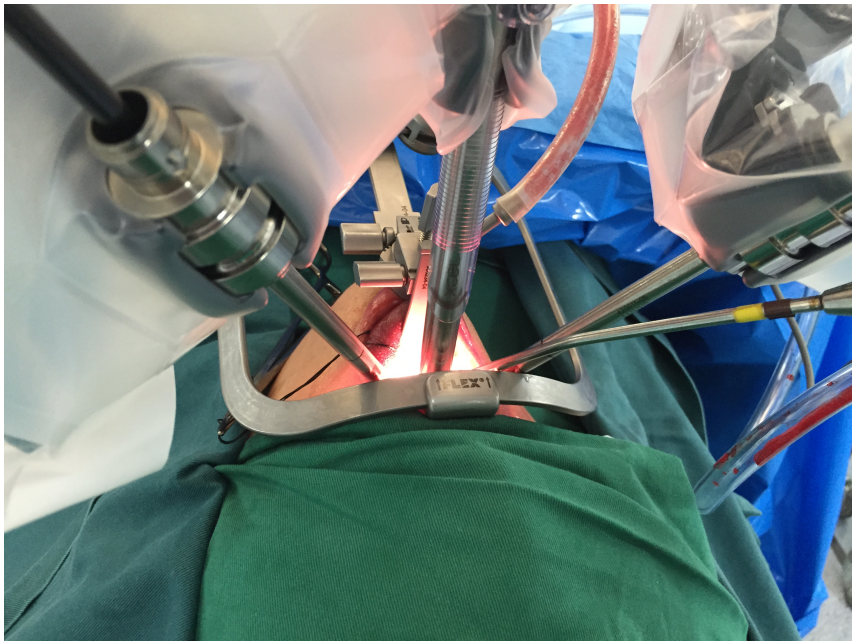


Figure 1: Operating Room Setup for *da Vinci* TORS

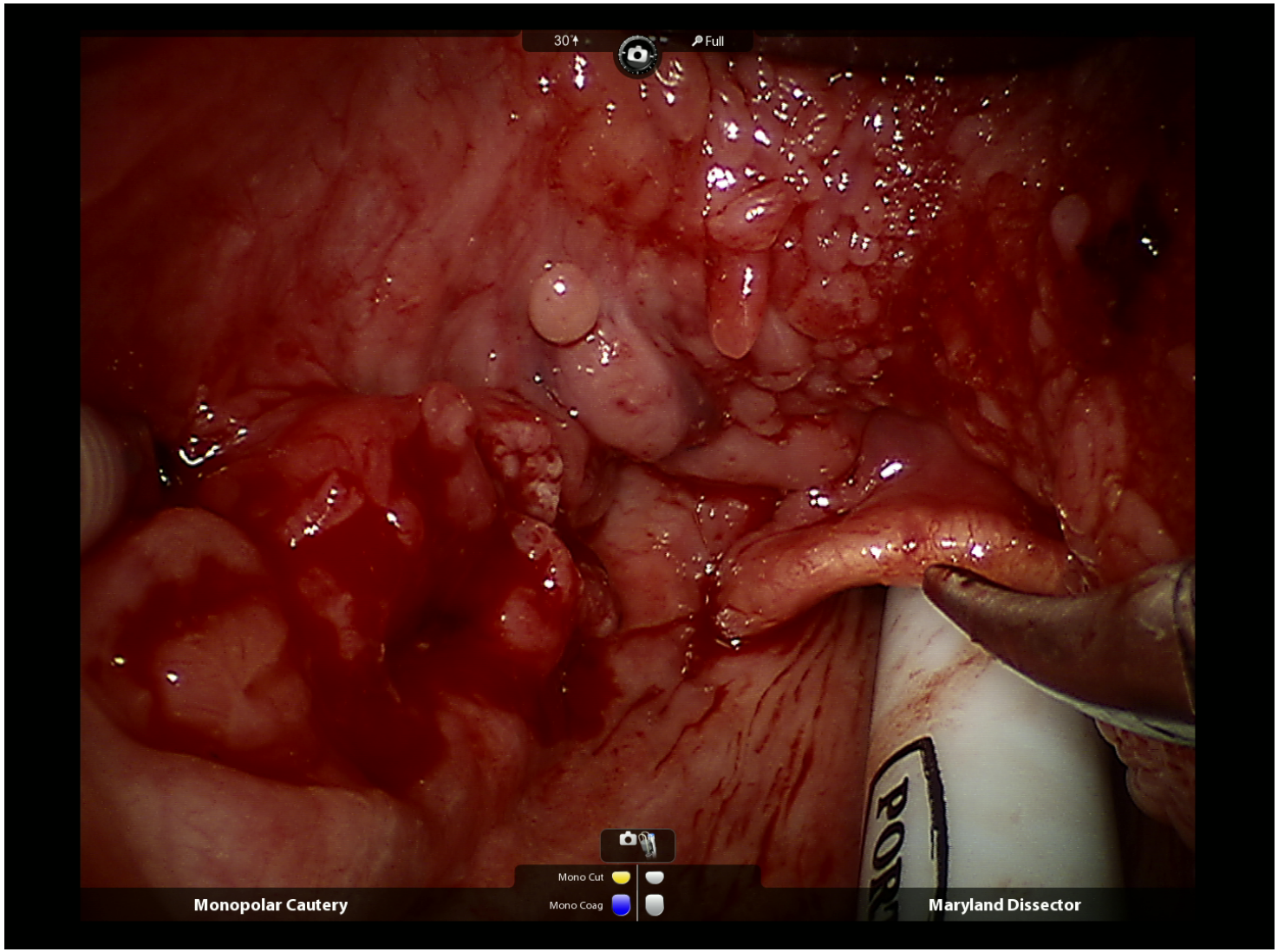


TORS set up

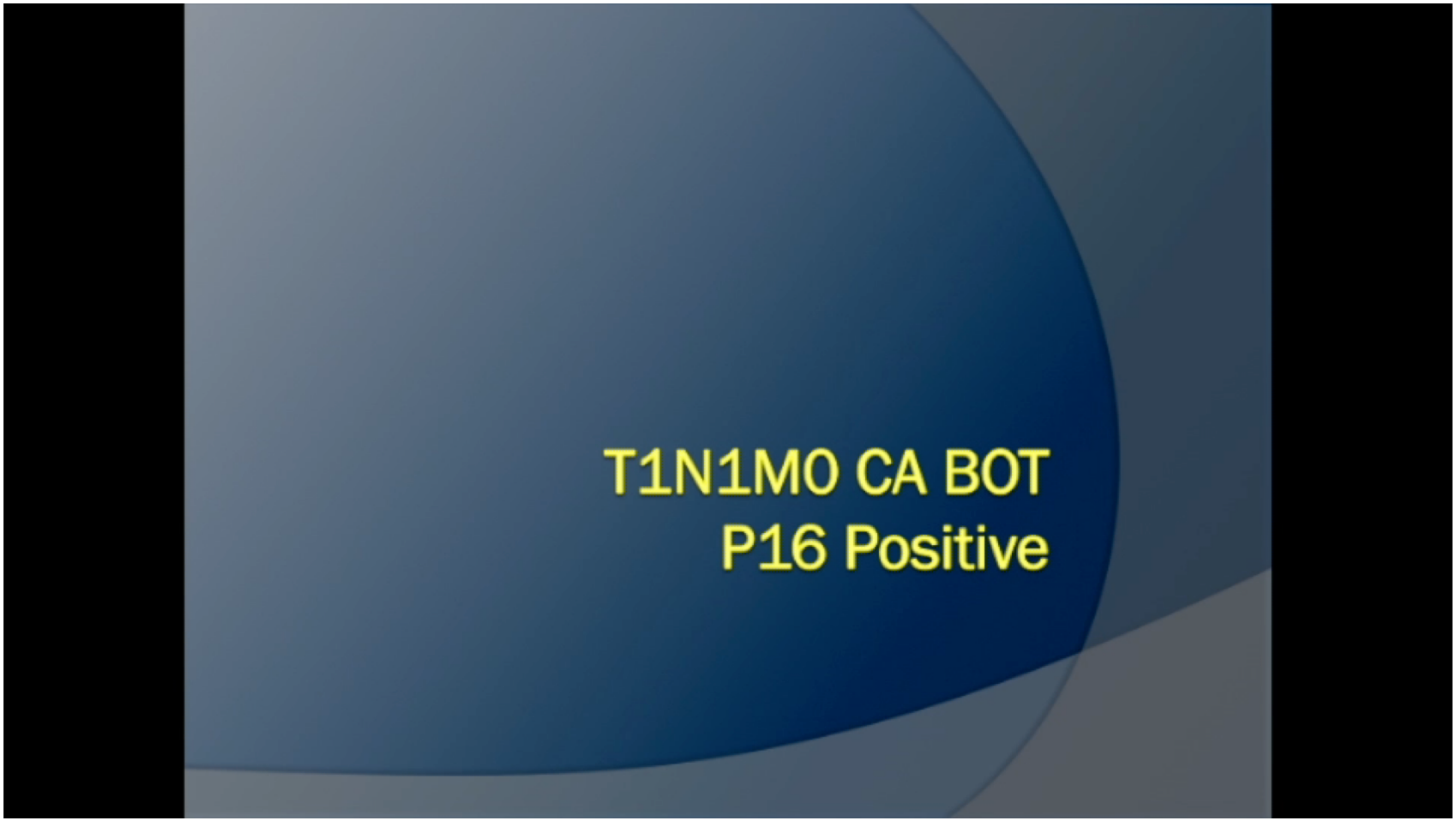




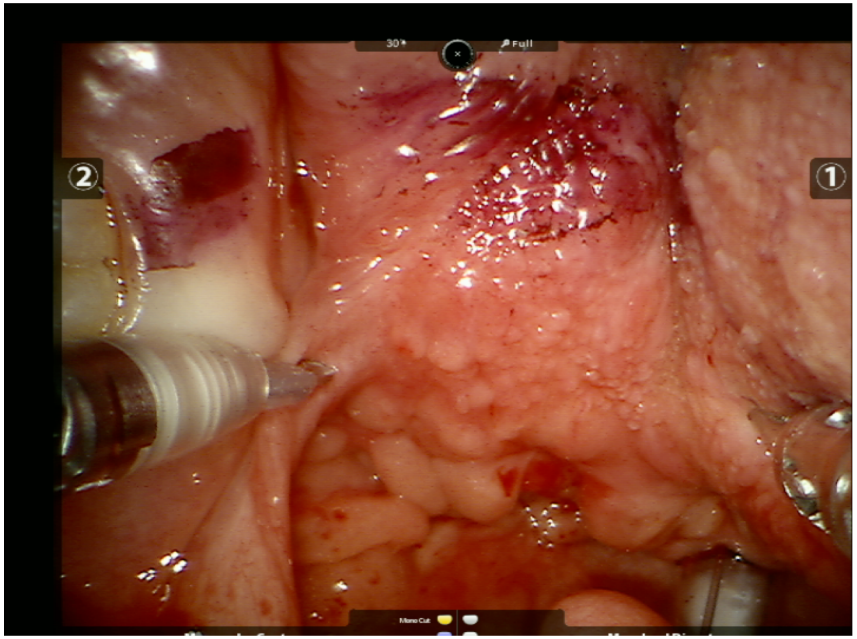
Transoral exposure

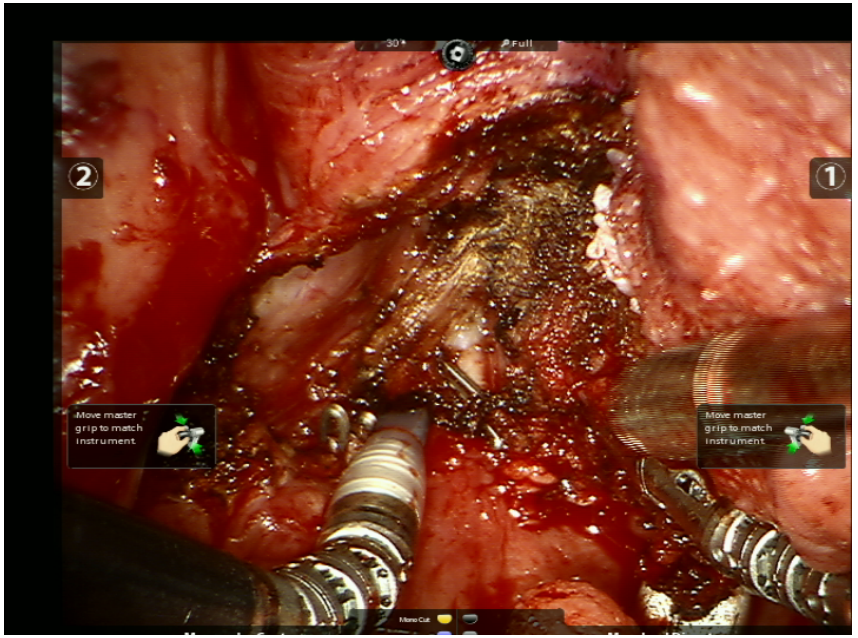


T1No SCC left tonsil

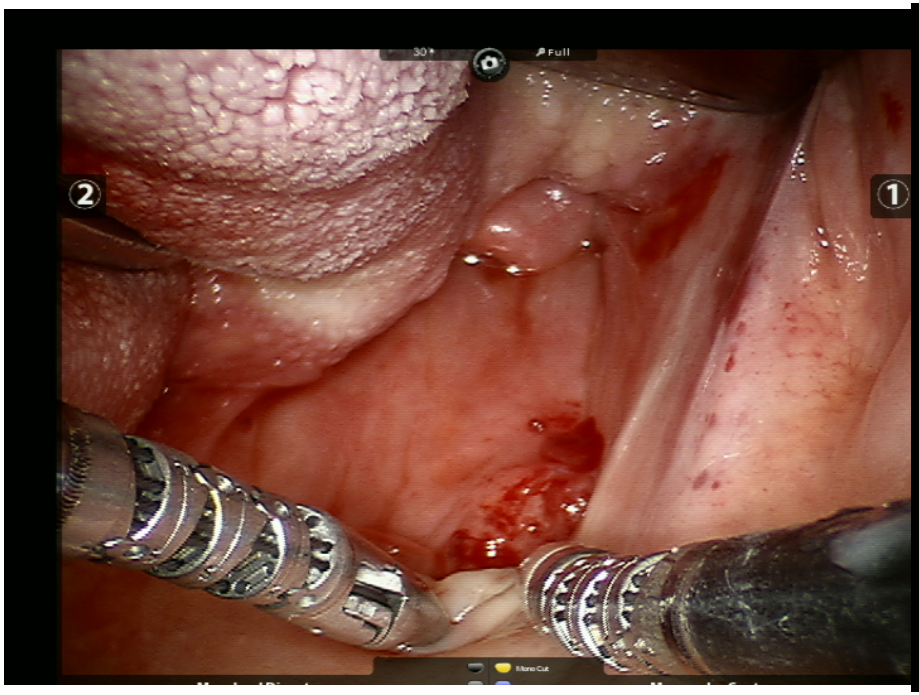

T1N1M0 CA BOT
P16 Positive

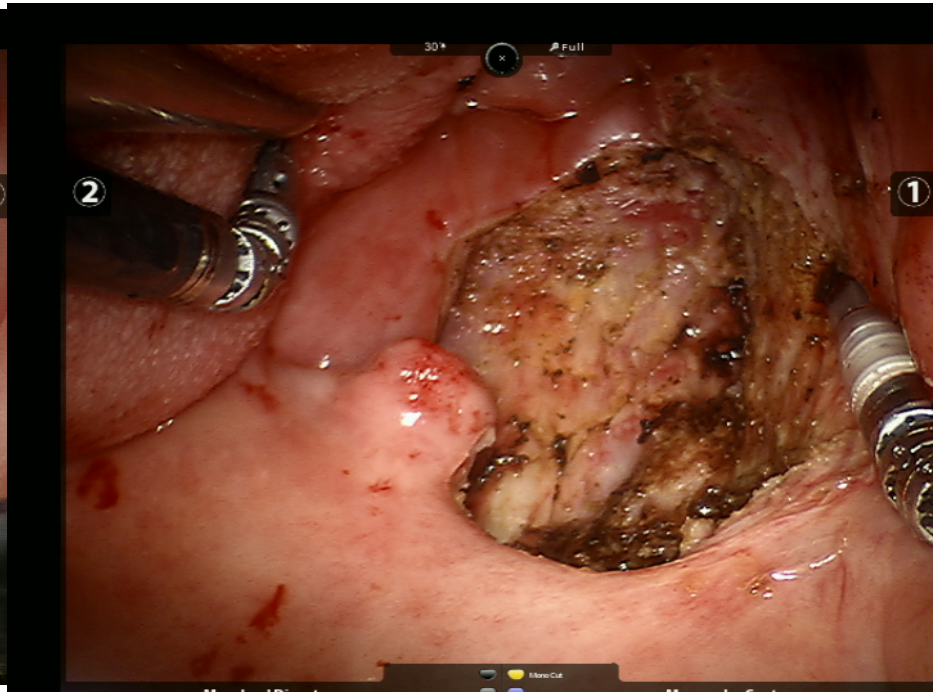
TORS for oropharyngeal cancer





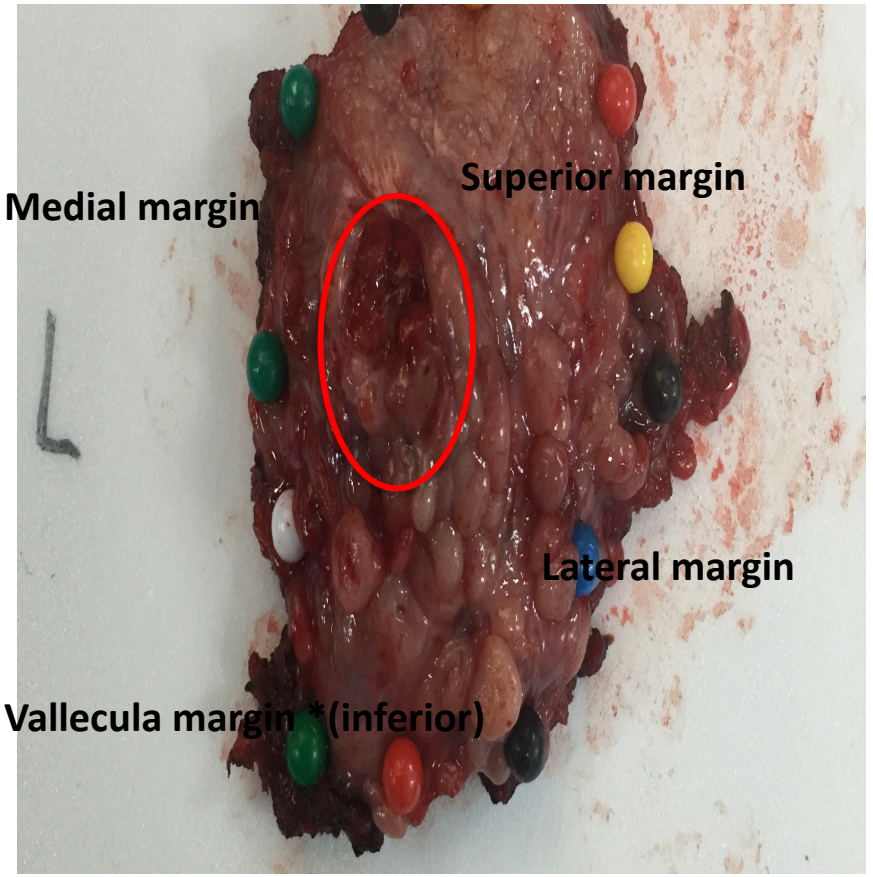
TORS for salvage





Oncologic results

- Primary Aim is negative margin resection



Pathology report

Margins:
Left aryepiglottic margin: 0.7 cm (J2)
Left base of tongue: 0.9 cm (J4)
Right base of tongue: 1.0 cm (J7)
Deep margin: 0.4 cm (J4)

DIAGNOSIS

(A) Right tongue base, (B) left tongue base, (C) right false cord, (D) left false cord, (E) Left pyriform, (F) Left arytenoid, (G) deep margin, and (H) pre-epiglottic tissue:
- Negative for malignancy.

(J) Tumour of the epiglottis, supraglottic laryngectomy:
- Squamous cell carcinoma, moderately differentiated, involving the epiglottis and extending to the left base of tongue.
- Margins are free of tumour.

[redacted]

Ordering Doctor: LIM CHWEE MING (08438G)

Results

glands. There is no evidence of malignancy.

DIAGNOSIS

(A) Left hypopharynx margin; biopsy: Negative for malignancy.

(B) Medial pharyngeal wall margin; biopsy: Negative for malignancy.

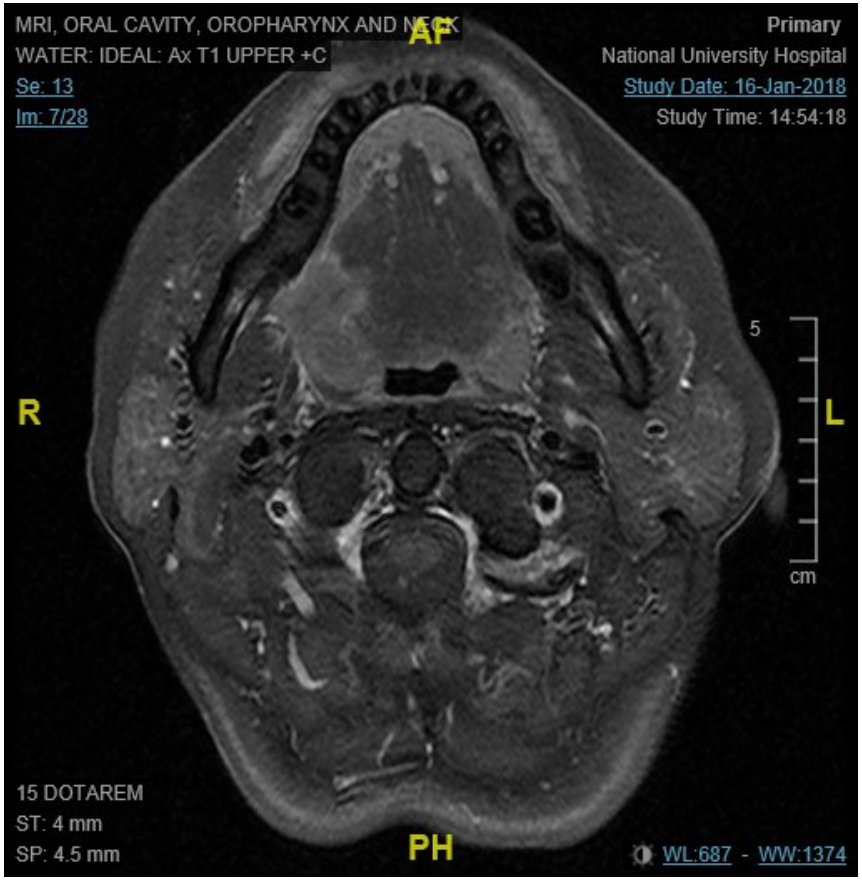
(C) Deep margin; biopsy: Negative for malignancy.

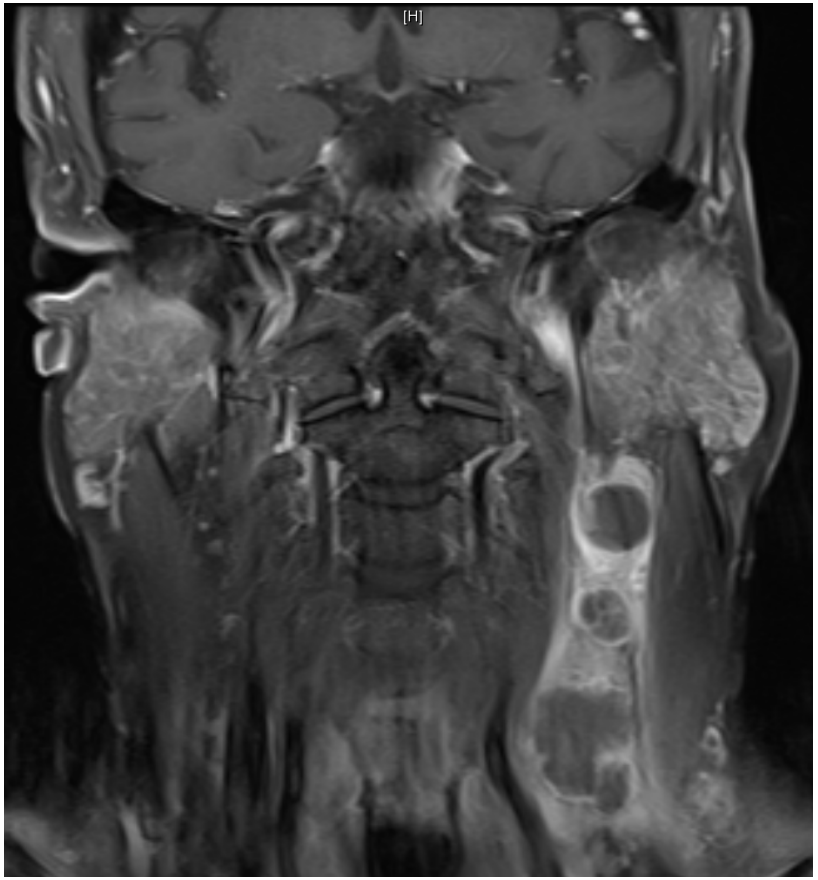
(D) Superior margin; biopsy: Negative for malignancy.

(E) Left tongue base margin; biopsy: Negative for malignancy.

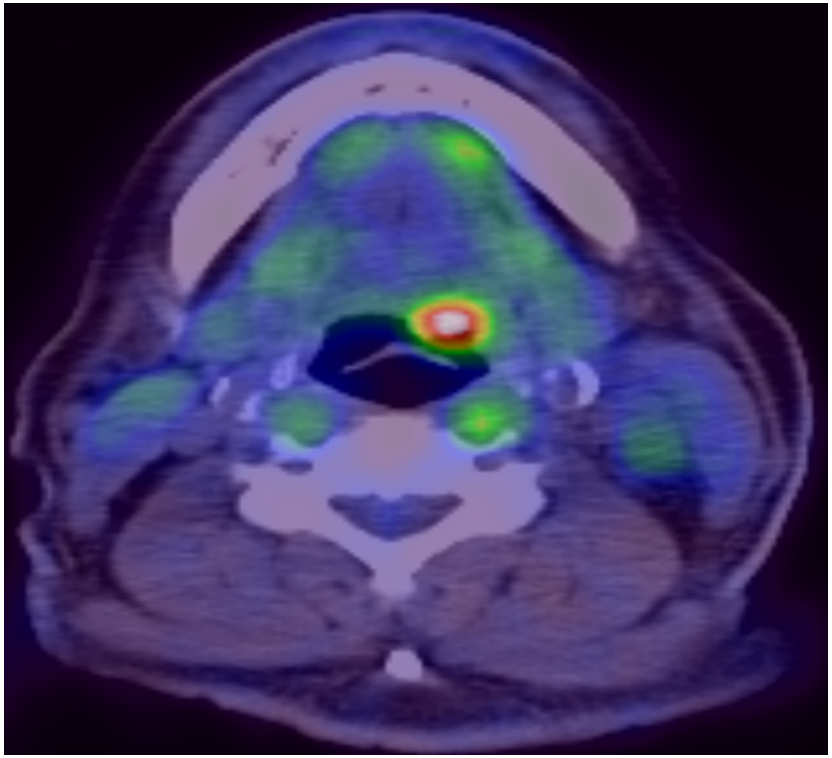
(F) Left pharyngeal wall tumour; partial oropharyngectomy:
- Squamous cell carcinoma, moderately differentiated.
- Tumour invades into superficial layers of skeletal muscle tissue.
- All margins are free of tumour.

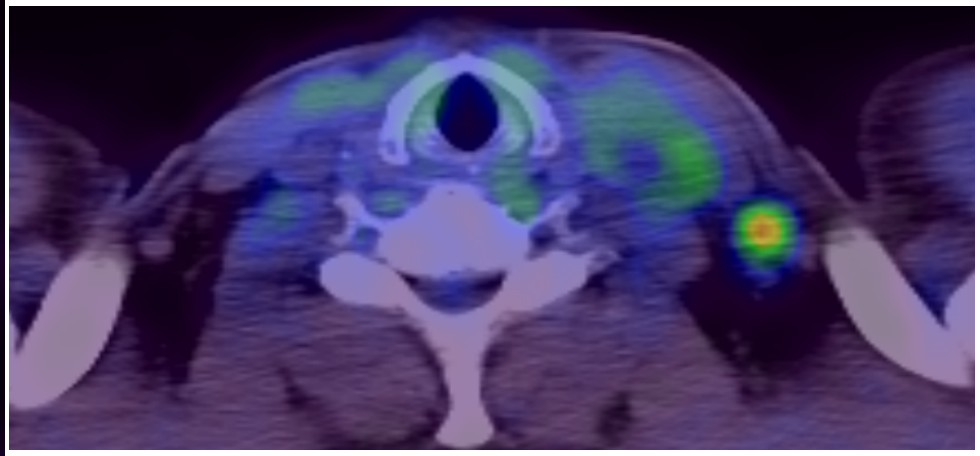
Appropriate selection





PET CT



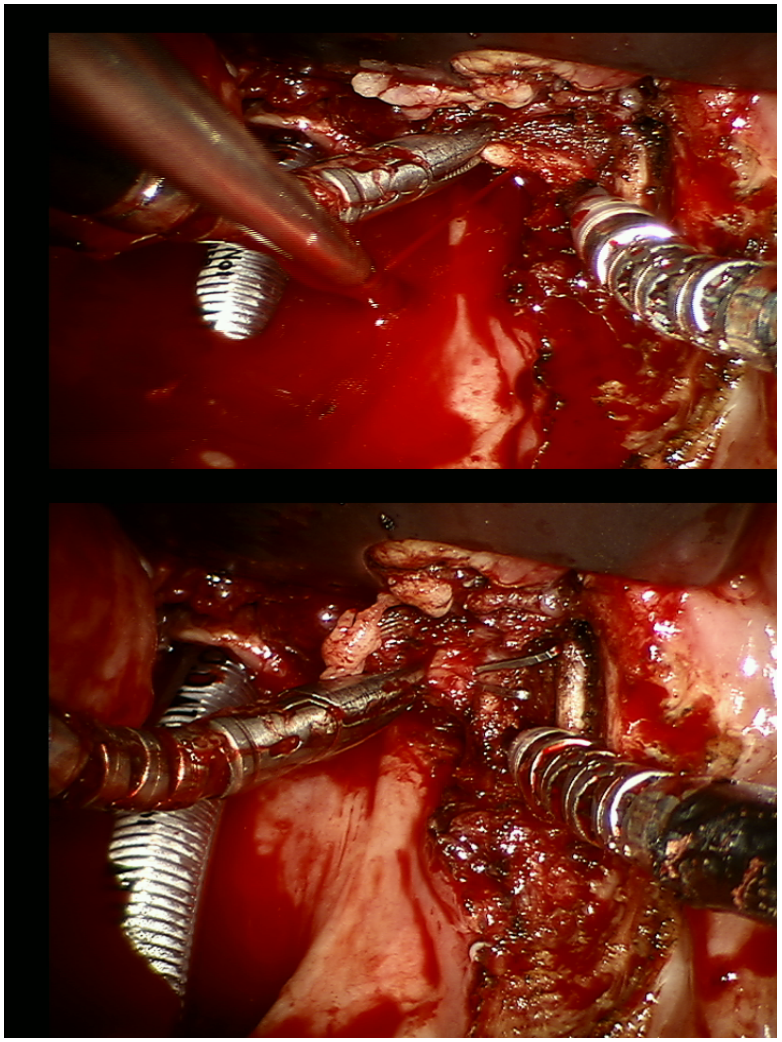


Managing bleeding complications in TORS

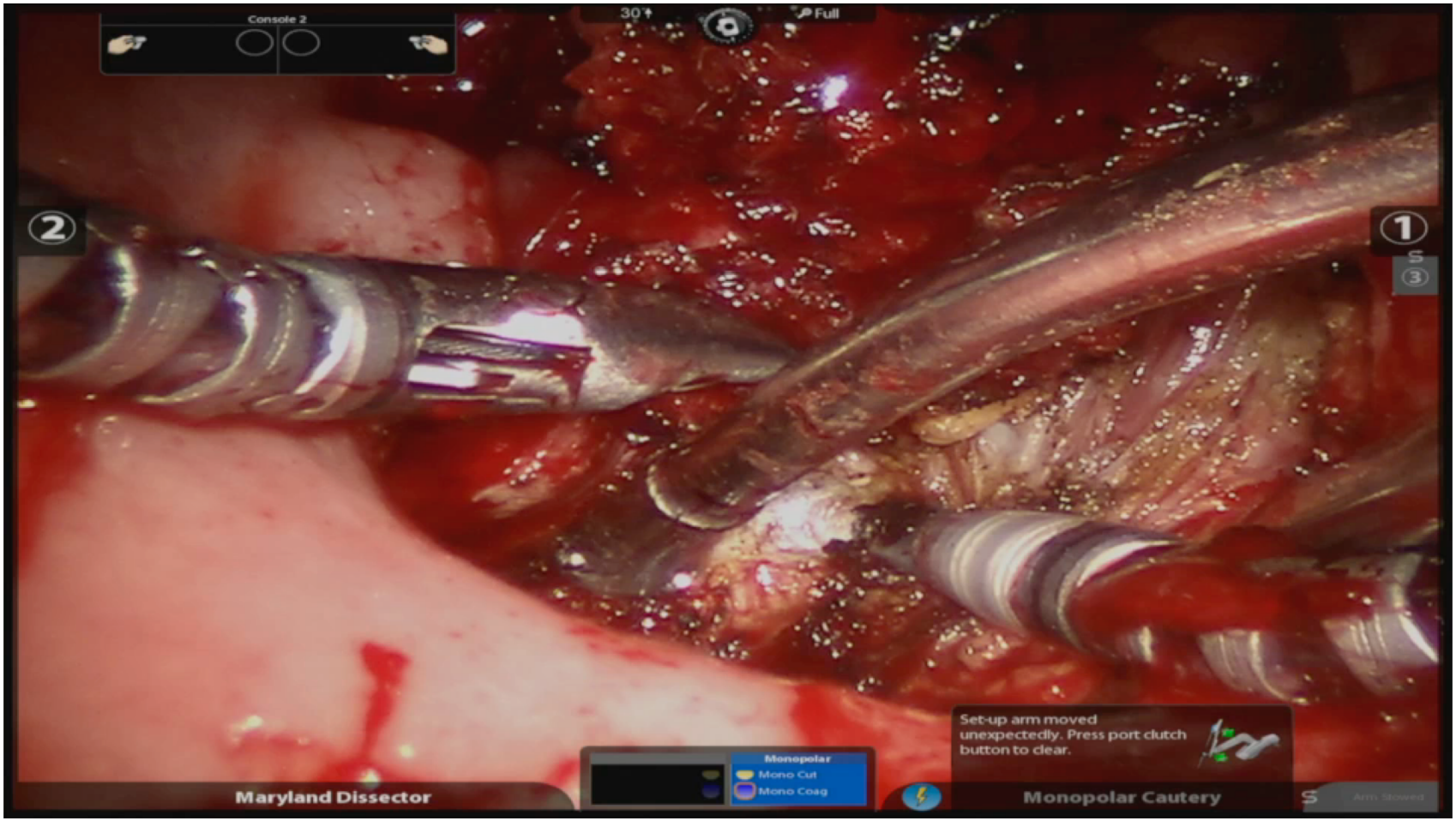
- Scenarios

1) Primary intraoperative bleed

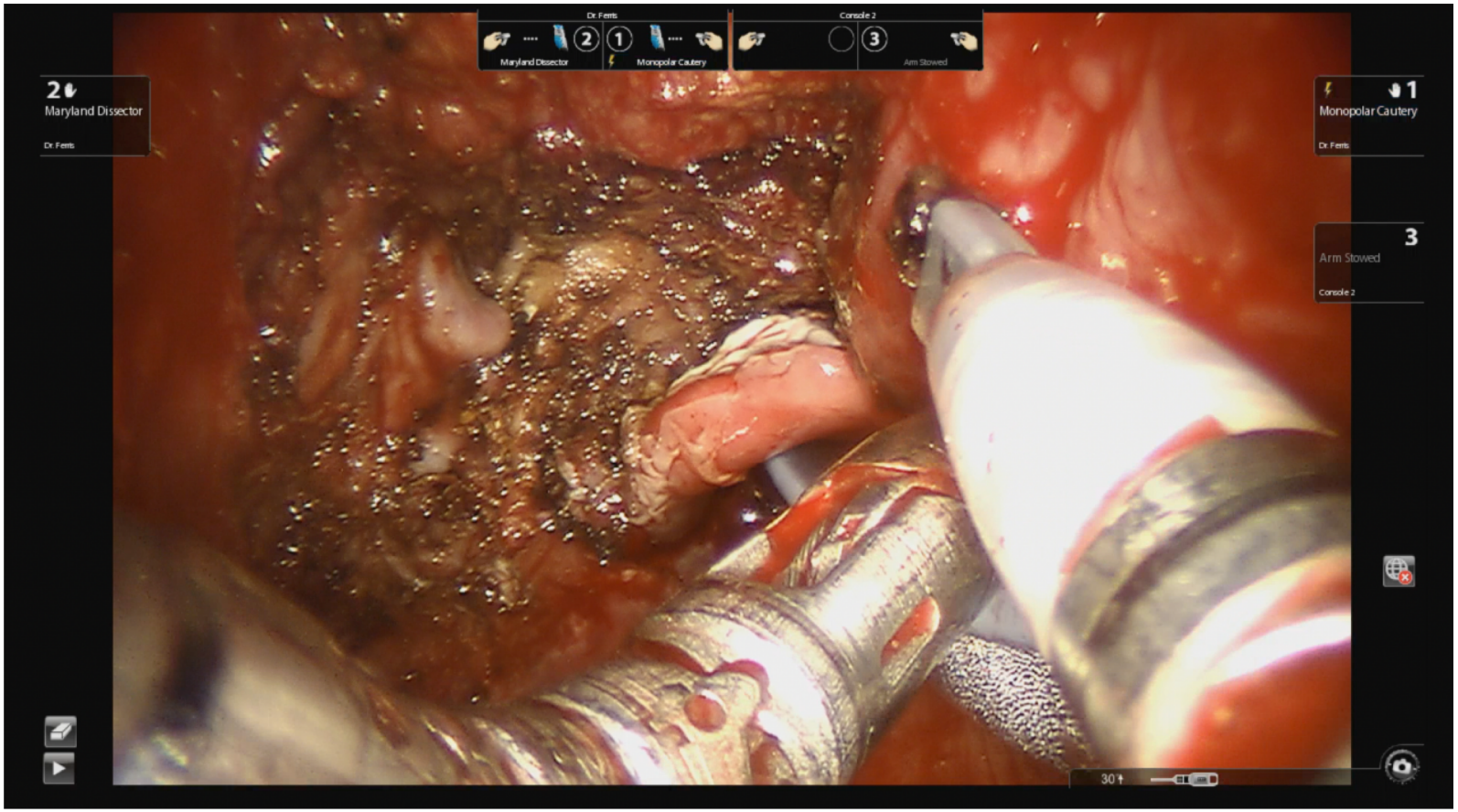
2) Secondary postoperative bleed

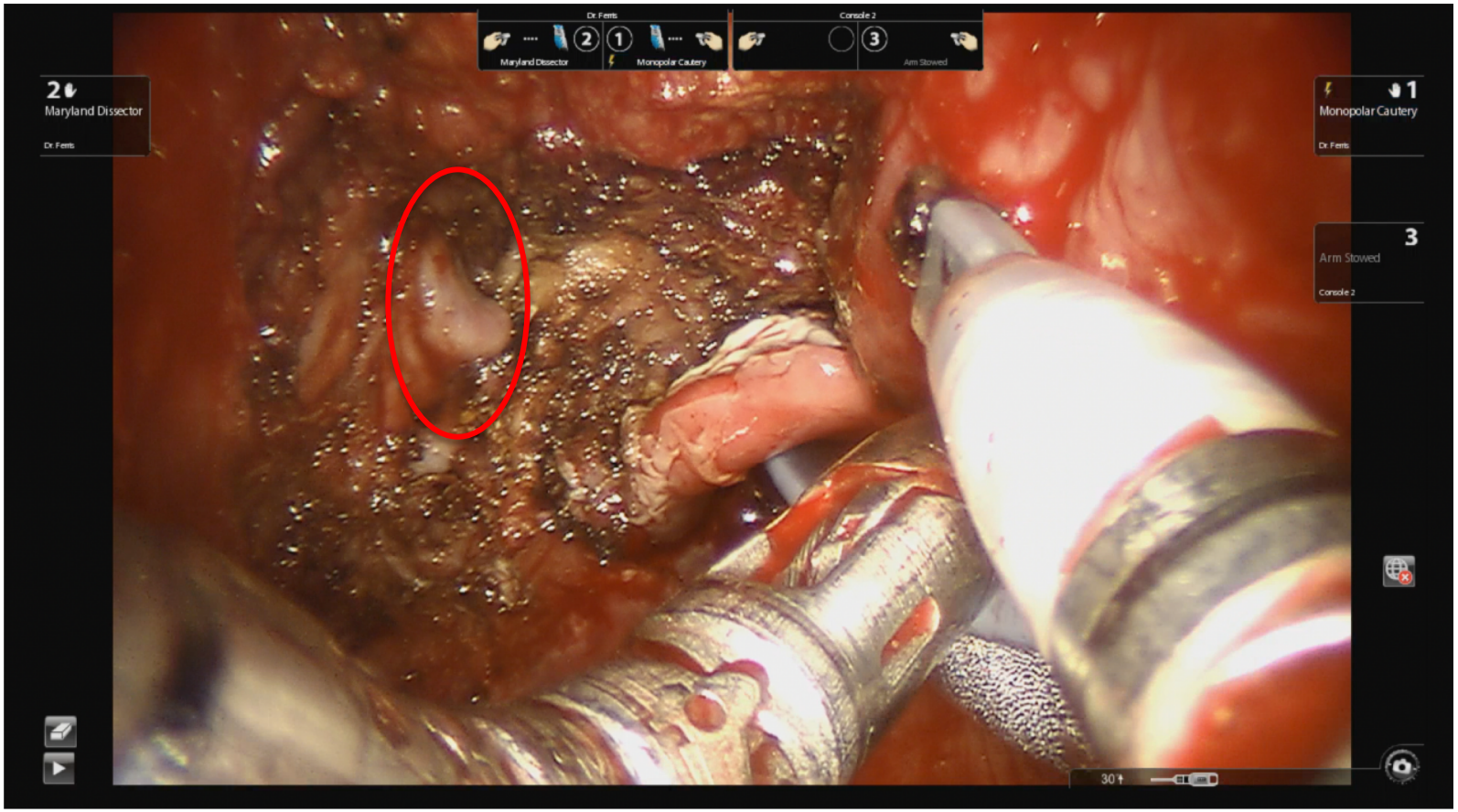


HEMORRHAGE DURING TORS


Console 2
30°
Full
2
1
3
Set-up arm moved unexpectedly. Press port clutch button to clear.
Monopolar
Mono Cut
Mono Coag
Maryland Dissector
Monopolar Cautery
Arm Stowed

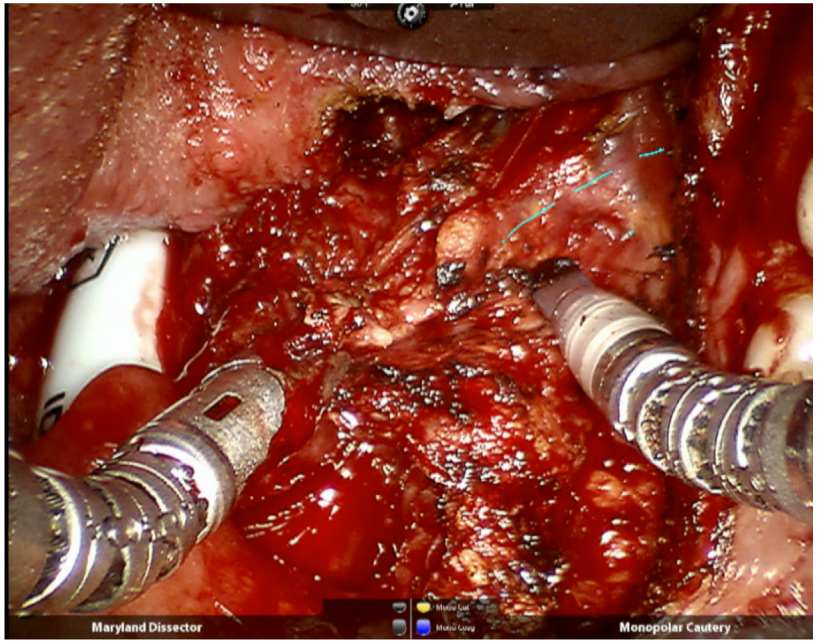
TORS T1 BOT SCC

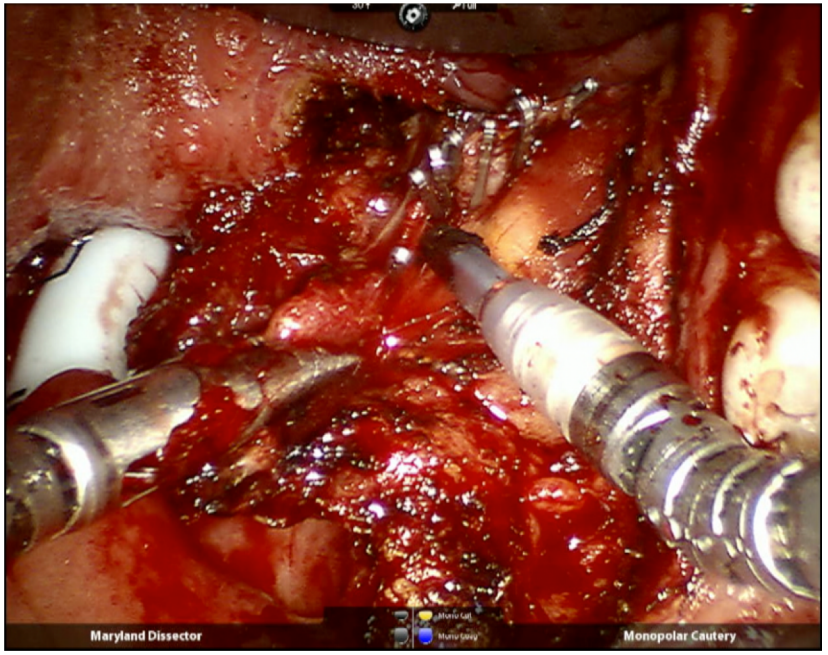

Dr. Ferris
2
1
Maryland Dissector
Monopolar Cautery
Console 2
3
Arm Stowed
2
Maryland Dissector
Dr. Ferris
1
Monopolar Cautery
Dr. Ferris
3
Arm Stowed
Console 2
30


Dr. Ferris
Maryland Dissector
Monopolar Cautery
Console 2
Arm Stowed
2
Maryland Dissector
Dr. Ferris
1
Monopolar Cautery
Dr. Ferris
3
Arm Stowed
Console 2
30

Transoral clipping of vessel during TORS

Pre-emptive clipping of vessels transorally





Analysis of post–transoral robotic-assisted surgery hemorrhage: Frequency, outcomes, and prevention

Rajarsi Mandal, MD,[1] Umamaheswar Duvvuri, MD, PhD,[1,2] Robert L. Ferris, MD, PhD,[1] Thomas M. Kaffenberger, BS,[3] Garret W. Choby, MD,[1] Seungwon Kim, MD[1]*

[1]Department of Otolaryngology, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, [2]Veterans Affairs Pittsburgh Health System, Pittsburgh, Pennsylvania, [3]University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania.

Accepted 16 April 2015
Published online 00 Month 2015 in Wiley Online Library (wileyonlinelibrary.com). DOI 10.1002/hed.24101

ABSTRACT: *Background.* Transoral robotic-assisted surgery (TORS) carries a small, but not insignificant, risk of life-threatening postsurgical hemorrhage. The purpose of this study was to analyze all post-TORS hemorrhagic events at our institution to establish preventative recommendations.

Methods. We conducted a retrospective review of 224 consecutive patients who underwent TORS for any indication at a single tertiary care institution.

Results. Twenty-two patients ($n = 22$; 9.82%) had varying degrees of postoperative bleeding. An impaired ability to protect the airway at the time of hemorrhage increased the rate of severe complications. Prophylactic transcervical arterial ligation did not significantly decrease overall postoperative bleeding rates (9.1% vs 9.9%; $p = 1.00$); however, there was a trend toward decreased hemorrhage severity in prophylactically ligated patients (3.0% vs 7.3%; $p = .7040$).

Conclusion. Prophylactic transcervical arterial ligation may reduce the incidence of severe bleeding following TORS. Post-TORS patients displaying an inability to protect the airway should be strongly considered for prophylactic tracheostomy to assist airway protection. *Head Neck* 00: 000–000, 2015

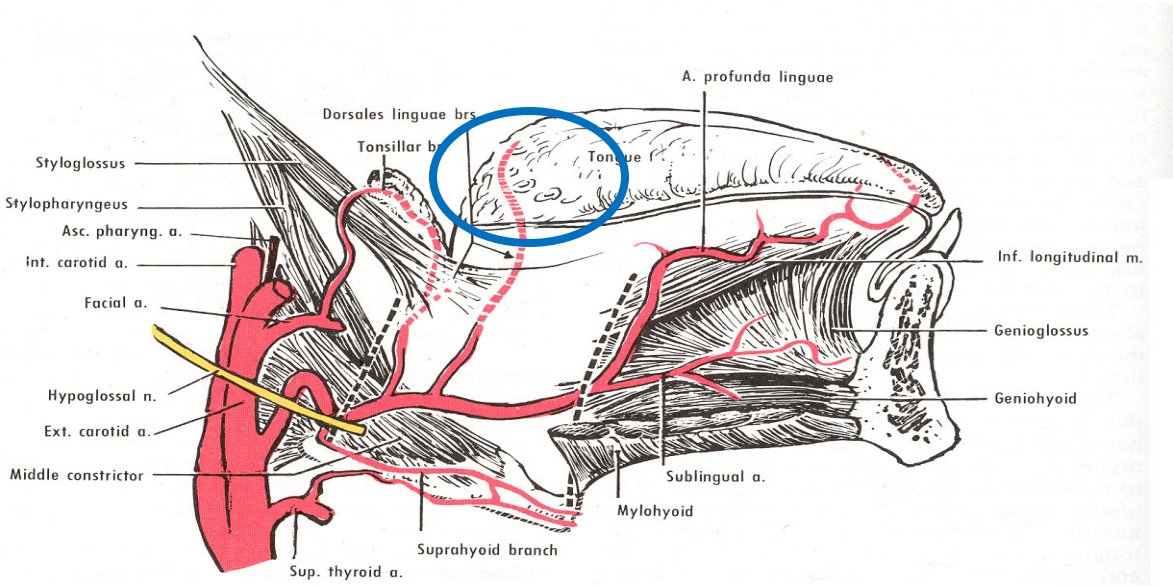
KEY WORDS: transoral robotic-assisted surgery (TORS), TORS hemorrhage, TORS bleeding, TORS complications, prophylactic arterial ligation

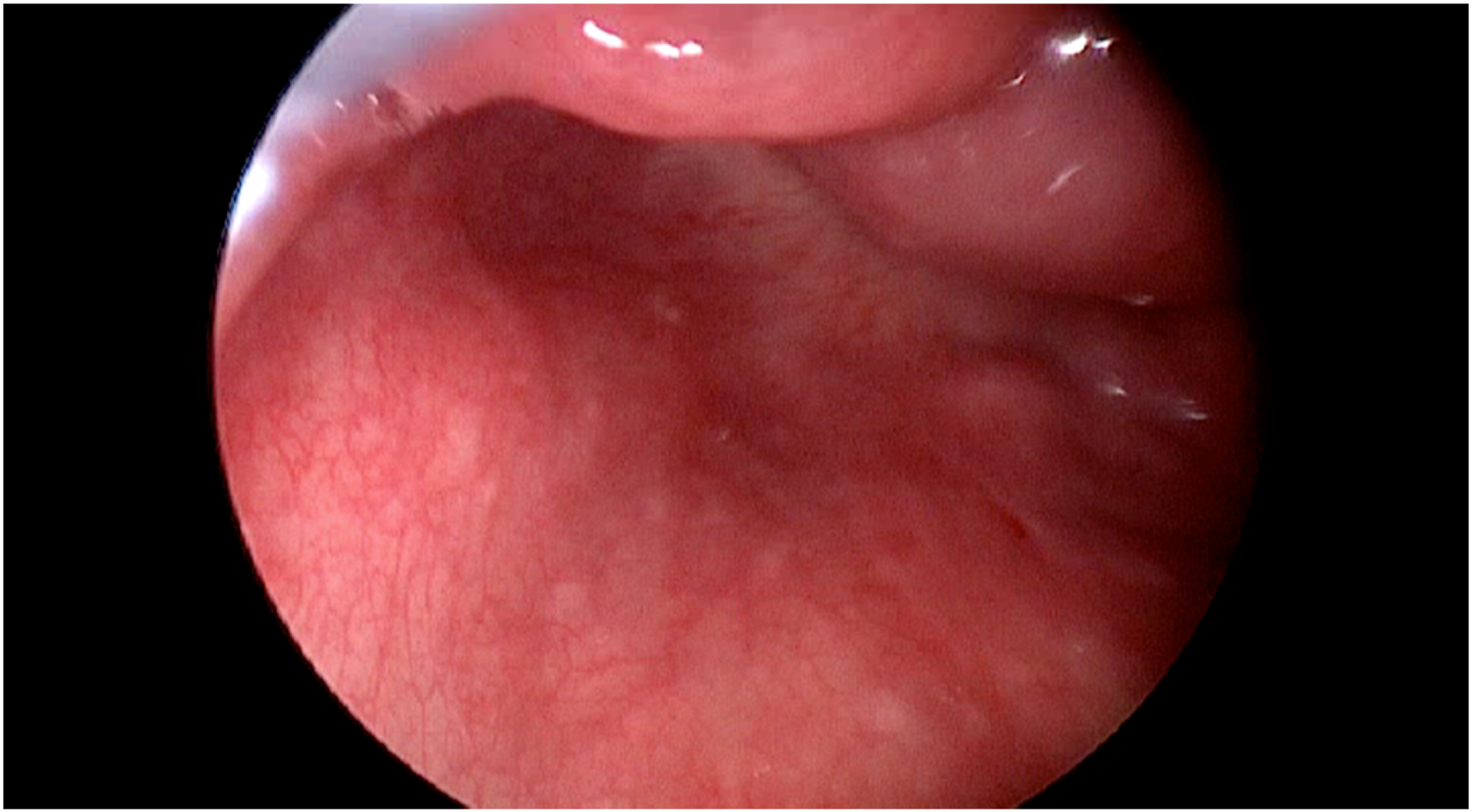
Summary

- Pre-emptive ligation of vessels in the neck appeared to decrease the severity of bleeding in patients undergoing TORS

- Airway control management is the utmost importance in minimizing mortality in patients who developed bleeding post TORS

Sagittal anatomy of lingual artery





Beware of anatomical variants

Optimizing your *da Vinci*® Program with 4th Generation System Technologies

da Vinci X™ System

Capability Meets Value

Optimized for Focused-Quadrant Surgery

da Vinci Xi® System

Advancing the State of the Art

Optimized for Multi-Quadrant Surgery

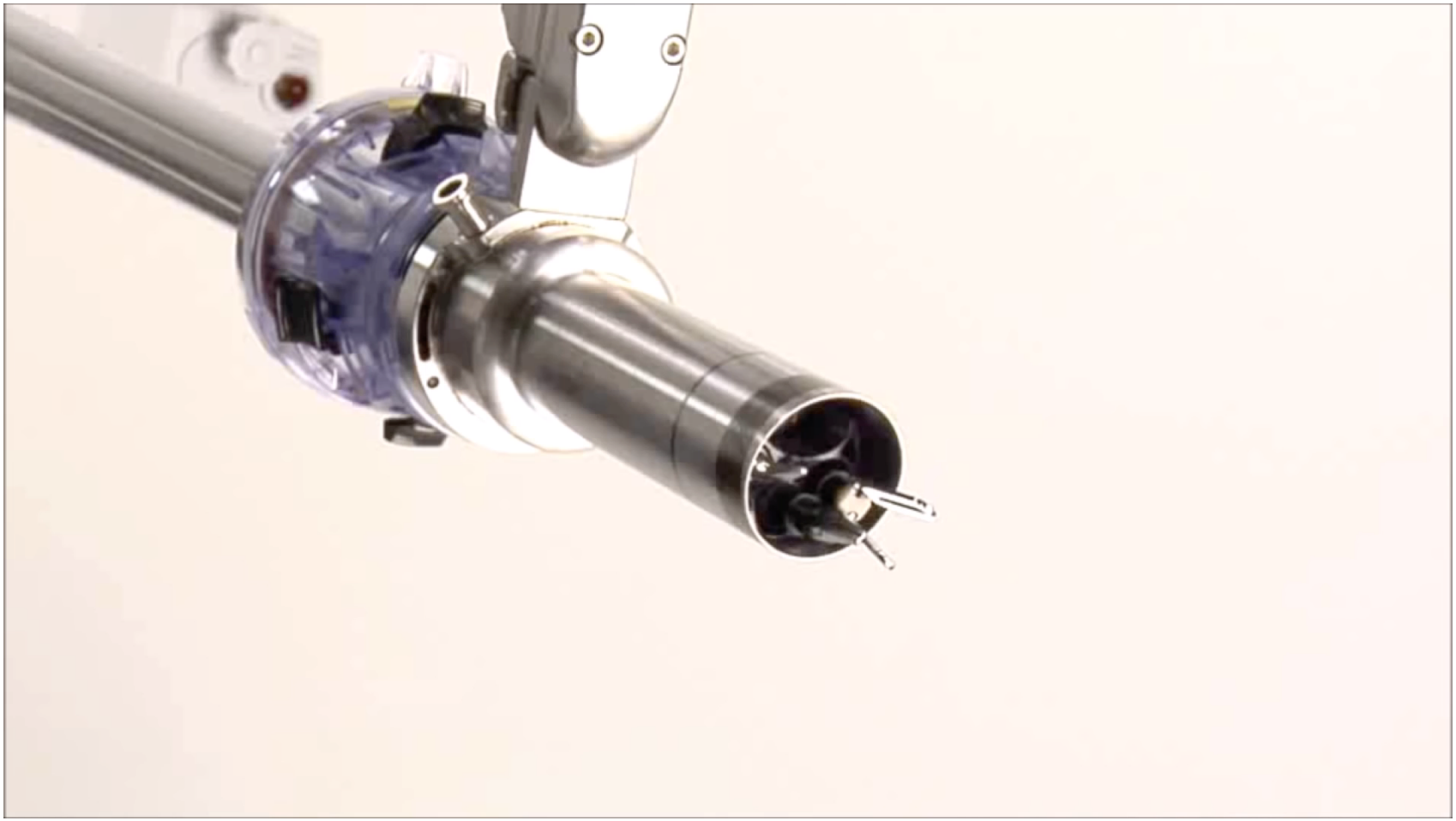
da Vinci SP™ System*

Leading Innovation

Optimized for Narrow-Access Surgery

da Vinci X and da Vinci SP are not currently registered or available for sale in Singapore.

**da Vinci SP Surgical System is still in development, not 510(k) cleared and the safety or effectiveness of the product has not been established. The product is not currently for sale in the US.*



Future directions

- 1) Flexible and adaptive robotic system

- 2) New platforms
- - ultrasound
- - Intraoperative margins evaluation –
- eg Raman spectroscopy
- - laser
- Vessel identification (real time)