Paranasal Sinuses and Skull Base: Open approaches

Dr. Patrick Gullane
Sinonasal Malignancy

- 3-5% of Head and Neck Malignancies
- Slight male preponderance (1.2-2.7:1)
- Most Common Histopathologies
  - Squamous Cell Cancer
  - Adenocarcinoma
  - Adenoid Cystic Carcinoma
- Maxillary Sinus is most common location
Incidence by Sinus

- Maxillary sinus: 70-80%
- Ethmoid sinus: 10-20%
- Frontal sinus: <5%
- Sphenoid sinus: <5%
- Nasal cavity: 20-30%
Are we making Progress
The Good News:
We are Doing Better!

What is the right treatment?

- Surgery
  - Endoscopic
  - Open Surgery (Maxillectomy, Craniofacial Resection)
- Radiotherapy
- Chemotherapy
- Molecular targeted agents

IT DEPENDS!!
Clinical Practice Guidelines

NCCN Guidelines™ Version 2.2011
Ethmoid Sinus Tumors

**CLINICAL PRESENTATION**
- Newly diagnosed; T1, T2
- Newly diagnosed; T3, T4a

**PRIMARY TREATMENT**
- Surgical resection\(^b\) (preferred)
  - or
  - Definitive RT\(^d\)
- Surgical resection\(^b\) (preferred)
  - or
  - Chemo/RT\(^c,d\)

**ADJUVANT TREATMENT**
- RT\(^d\)
  - or
  - Observation\(^e\) for T1 only (category 2B)
  - or
  - Consider Chemo/RT\(^c,d\) (category 2B)
  - if adverse features\(^f\)
- RT\(^d\)
  - or
  - Consider chemo/RT\(^c,d\) (category 2B)
  - if adverse features\(^f\)
The Problem - Histology


<table>
<thead>
<tr>
<th>Covariate</th>
<th>No. of patients</th>
<th>5 yr DSS (%)</th>
<th>Univariate analysis (log-rank test)</th>
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<tbody>
<tr>
<td>Histology</td>
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<td>Esthesioneuroblastoma</td>
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<td>Mucosal melanomas</td>
<td>53</td>
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</table>
Right Tool for the Right Job
Impact of Skull Base Surgery
Paul Tessier

Alfred Ketcham

Tessier renewed the interest of plastic surgeons around the world in innovative operative procedures for treatment of severe congenital facial deformities.

Ketcham’s pioneering work on “Craniofacial Resection for Malignant Tumours of the Paranasal Sinuses” extending to the skull base opened the doors for neoplastic skull base surgery of the anterior cranial fossa.
Evolution of Skull Base Surgery

- Early pioneers
- Open skull base
- Radiosurgery
- Endoscopic skull base
- Multiport

Carl Snyderman
# 35 Years in Skull Base Surgery

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1977</td>
<td>Entry in SBS</td>
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<tr>
<td>1970s - 1980s</td>
<td>Enthusiasm</td>
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<td>1990 - 2000</td>
<td>Early Experience</td>
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<td>Realities &amp; Frustrations</td>
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<td>Morbidity/Outcomes - QOL</td>
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<td>Benchmark data</td>
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<td>Leadership - NASBS</td>
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<td>2005</td>
<td>Teaching, Training, Refining, Advancing, Adapting and Exploring</td>
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<tr>
<td>2017</td>
<td>Inspiration, Education &amp; Exploration of the future</td>
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</table>

- **1977**: Entry in SBS
- **1970s - 1980s**: Enthusiasm
- **1980s**: Technical Refinements
- **1990 - 2000**: Early Experience
- **1990 - 2000**: Realities & Frustrations
- **1990 - 2000**: Morbidity/Outcomes - QOL
- **1990 - 2000**: Ethics
- **1990 - 2000**: Antibiotics Trial
- **1990 - 2000**: Int’l Collaborative Study
- **1990 - 2000**: Benchmark data
- **2005**: Leadership - NASBS
- **2017**: Teaching, Training, Refining, Advancing, Adapting and Exploring
- **2017**: Inspiration, Education & Exploration of the future
Evolution in the Approaches in Skull Base Surgery: 

Has Effected Outcome with -

- Introduction
- Skepticism
- Enthusiasm
- Aggressiveness
- Techniques
- Experience
- Techniques -
- Complications
- Realities
- Outcomes – QOL
- Cost effectiveness
- Ethics

1960’s 1970’s 1980’s 1990’s 2017

“`The great thing in the world is not so much where we stand, as in what direction we are moving.”`

Oliver Wendell Holmes

![Survival % Graph](image)
Definition of a Skull Base Tumour

“A tumour than transcends the skull base necessitating a combined intra and extracranial approach for its ablation.”
Skull Base Classification 1989

Region I  Anterior
Region II  Anterolateral
Region III  Lateral/Posterolateral

Irish, Gullane, Gentili, Dolan 1988
Region I

• Tumours Involving the Anterior Cranial fossa
• Cancers arising
  – Sinuses
  – Orbit
  – Bone of skull base
  – Skin
  – Intracranial origin
Region I - Selection of Approach

Depended on 3 Factors
- Tumour type
- Extent of neoplasm
- Need for pre/post op radiation

Open approach vs. Endoscopic
Treatment

Often Requires Combined Therapy

- Surgery
- Radiation
  - IMRT
  - Proton beam
  - Neutron beam
- Chemotherapy
Conventional Surgical Approaches: Craniotomy + one below

- Degloving
  ± maxillotomy
  ± maxillectomy
  ± le Fort I
- Lateral rhinotomy ± medial maxillectomy
- Weber Ferguson Incision
  ± maxillectomy ± orbit
  ± maxillotomy
- Supra maxillectomy ± skin, orbit
- Extended maxillectomy ± skin, orbit
- Subcranial approach
- Trans-orbital approach
Realised Reconstruction was Vital

Lesson Learned

- Closure without specific reconstruction
- Local flaps
- Pedicled flaps
- Free flaps

Pitfalls of no reconstruction.
Development

How Reconstruction Impacted the Outcome of Skull Base Surgery.
Toronto Experience

• 1988 – Dr. Alf Ketcham
• “Born 20 years too soon”
Goals of Cranial Base Reconstruction

- Provision of secure dural seal – Early major complication using endoscopic approach
- Dead space obliteration
- Suspension and support of neural structures
- Provision of bone and soft tissue cover
- Maintenance of function
- Achievement of optimal cosmesis
Reconstructive Options Region I-Limited Defect

- Pericranial flap + Skin Graft 70%
- Fasciocutaneous flap
  - Forearm
  - Lateral Arm
  - Anterolateral Thigh
Analysis of Best Approach Within Each Region

When to use Endoscopic or Open Resection? Controversial and Revolutionary
Planning the Next Attack on Skull Base Cancer 2006-Open or Endoscopic? Revolution

Open approach vs Endoscopic

Beginning of the Revolution
Shah, Draft, Stamm, Stamberger, Wilson

Kassam Snyderman
Conventional Approaches

- Conventional –
- Lateral Rhinotomy + Craniotomy
- Recognised that Improved Reconstruction reduced complication rate and changed the outcome.
1989-18 year old: Poor Results
SCC Right Ethmoid Sinus
The Pericranial Flap

Pneumocephalus
Bone Flap Lost

Peri-Cranium

Secondary Repair
Secondary Reconstruction

Hydroxyapatite

7 years post op
Proptosis-Chondrosarcoma

Craniotomy

Lateral Rhinotomy

Pericranial Flap
Rectus Abdominis Muscle

Inferior Epigastric Artery

10 yrs Postop
Approach to Extensive Tumours
Tumours that involve brain, orbit and skin.

“Will always need an open approach in my opinion”
Selection of Approach - Eye invaded

- 29 year old University Professor of music
- 3 month history of diplopia
- Diagnosis - left ethmoid retro orbital squamous cell carcinoma

Open most appropriate
Investigations:

- CT Scan
- MRI Scan

- The imaging revealed invasion of the anterior skull base, orbit and maxillary sinus.

Options in treatment?
Management:

• Combined craniofacial resection with postoperative radiotherapy

? Reconstrcutive Options
Orbital defect – How would you manage it?
9 years post-op

15 years post-op
Selection of Approach

Esthesioneuroblastoma-Change

• 43 year old man
• 1 year history of right sided nasal obstruction and intermittent frontal headaches.
• Examination - mass right nasal cavity with extension into the anterior and posterior ethmoid cells.
Investigations:
- CT Scan
- MRI Scan
- Biopsy - Esthesioneuroblastoma

What approach would you use to-day?
Endoscopic approach
Management – 1996?  
Endoscopic – 2017

- Combined craniofacial resection with postoperative radiotherapy.
- Craniofacial resection with postop irradiation and chemotherapy.
- Endoscopic transnasal excision with postoperative radiotherapy.
- Irradiation alone.

5 yrs post-op
Intracranial En-Plaque Recurrence at 7 yrs

Maybe endoscopic resection with post-operative radiotherapy may reduce the possibility of en-plaque recurrence? Reduce risk of dural seeding

Squamous Cell Carcinoma left maxilla/skull base invasion
Rectus Abdominis Flap

Combined Cranofacial Resection
8 years post Combined Therapy

Minimal access surgery not an option.
Why Preserve the Eye?

“The precious gift of sight can be matched only by the gift of life itself”

Robert S. Pollack
What about Quality of Life?
Development

How Reconstruction Impacted the Outcome of Skull Base Surgery. Toronto Experience

• 1988 – Ketcham
• “Born 20 years too soon”
Impact of Cranial Base Reconstruction

Flap Selection in Cranial Base Reconstruction.


Neligan, P. C. M.B., F.R.C.S.(C); Mulholland, S. M.D.; Irish, J. M.D., F.R.C.S.(C); Gullane, P. J. M.B., F.R.C.S.(C); Boyd, J. B. M.D., F.R.C.S.(C); Gentili, F. M.D., F.R.C.S.(C); Brown, D. M.D., F.R.C.S.(C); Freeman, J. M.D., F.R.C.S.(C)
Impact of Cranial Base Reconstruction
Uncomplicated Wound Healing

- Local: 79.4%
- Pedicled: 64.7%
- Free: 90%

n=127
Impact of Cranial Base Reconstruction

Incidence of Meningitis

- Local: 3.7%
- Pedicled: 5.9%
- Free: 0%

n=127
Impact of Cranial Base Reconstruction

- Local: 14.8%
- Pedicled: 11.8%
- Free: 5%

n=127
Impact of Cranial Base Reconstruction

Incidence of Abscess

- Local: 9.2%
- Pedicled: 17.6%
- Free: 0%

n=127
Results

- Physical functioning
- Role physical
- Bodily pain
- General health
- Vitality
- Mental health
- Social functioning

All within normal range for the general population

Role Emotional

Lower than the population norms

Problems with work or other daily activities as a result of their emotional concerns regarding recurrence.
We Are at a Crossroads

Open vs Endoscopic
The Trade-off

• **Open Approaches**
  - Better visualization
  - En bloc resection
  - Dealing with vascular injuries
  - Access for more extensive surgery

• **Endoscopic Approaches**
  - Better visualization
  - Less brain retraction
  - Lower complication rates?
  - Better quality of life
  - Shorter hospital stay
35 Years in Skull Base Surgery

- Complications - 25-40%
- Infection was a problem
- Reported outcomes data were not satisfactory
- Case selection was a problem
- Quality of life of the patient was not studied

Entry in SBS

Enthusiasm

Technical Refinements

Early Experience

Realities & Frustrations

- Morbidity/Outcomes - QOL
- Ethics

1977

1970s - 1980s

1990 - 2000

2017
Mortality/Morbidity From Skull Base Surgery

- Overall Mortality: < 10%
- Minor Complications: +15%
- Major Complications: +25%
- Complications Overall: +40%

Collective review from literature in 1990
Complications of Craniofacial Surgery

- Infection
  - Wound sepsis
  - Osteomyelitis
  - Meningitis

Avoidance

- Smaller bone flaps
- Subcranial approach
- Isolation of bone flap with galeal-pericranial flap
- “Wrapping technique”
35 Years in Skull Base Surgery

- 1977
- 1970s – 1980s
- 1990 - 2000
- 1996

- Entry in SBS
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- Antibiotics Trial

- Prophylactic antibiotics were given at random
- Choice of antibiotics was random
- The length of time for antibiotics was variable
- A definitive study was necessary

Antibiotics Trial

- • Prophylactic antibiotics were given at random
- • Choice of antibiotics was random
- • The length of time for antibiotics was variable
- • A definitive study was necessary
Study of Prophylactic Antibiotics for Cranio Facial Surgery

- Audit of all infectious complications till 1996
- Review of culture reports
- Preliminary trial with three sets of Antibiotic regimen
- Optimal choice of Antibiotic combination
- Ceftazidime, Vancomycin and Metronidazol

Rate of Infectious complications is down to less than 2%, since 1996, and all are minor.

Sal Caruana and Dennis Kraus (Triological Thesis)
35 Years in Skull Base Surgery

- No reliable data were available.
- Benchmark data were necessary to move forward
Results of Skull Base Surgery for Malignant Tumours 1960-2000

5 year survival

Ketchum 1963
- 1960’s – 1970’s 50%
Cheeseman
- 1970’s – 1980’s 50%
Shah 1992
- 1980’s – 1990’s 63%
Irish, Gullane, Gentili 1994
- 1983 – 1992 54%
International Study of Skull Base Surgery for Malignant Tumors

- **Red**: Approached / Not participated
- **Red Star**: Approached / Participated

2017
<table>
<thead>
<tr>
<th>Name</th>
<th>Contributions</th>
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<td>Patrick Bridger</td>
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<td>Giulio Cantu</td>
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<td>Tony Cheesman</td>
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<td>Patrick Gullane</td>
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<td>Sultan Pradhan</td>
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<td>Victor Schramm</td>
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<td>Jatin Shah</td>
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<td>Carl Snyderman</td>
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<tr>
<td>William Wei</td>
<td>31</td>
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<td><strong>TOTAL</strong></td>
<td><strong>1,541</strong></td>
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International Collaborative Study Group
Craniofacial Surgery for Malignant Skull Base Tumors

• 1541 patients treated between 1956-2000 were accrued

• Exclusions:
  No pathologic information = 26 (2%)
  No Follow-up data = 88 (6%)
  Benign tumors = 120 (8%)

• 1307 patients eligible for analysis
ICSG for CFS
Survival

5-year recurrence free survival 53%
ICSG for CFS

DSS: Impact of Histology

Follow-up Interval (Months)

Proportion Surviving

Group I: ENB, Skin, Low grade sarcoma (79%)

Group 2: Hi grade sarcoma, SCC, Salivary, Other malignancies (57%)

Group 3: Mucosal melanoma, Undifferentiated/anaplastic (30%)

p < .0001
DSS: Impact of Intracranial Extension

Proportion Surviving

Follow-up Interval (Months)

p<.0001

None 66%
Bone 59%
Dura 54%
Brain 29%
ICSG for CFS

Margins of Surgical Resection

- Negative: 63%
- Positive: 15%
- Close: 17%

*Data not available in 185 patients (14%)
ICSG for CFS
DSS: Impact of Surgical Margin Status

Proportion Surviving

Follow-up Interval (Months)

Negative 74%
Positive 38%
## ICSG for CFS
Prognostic Predictors of Disease-Specific Survival

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Predictors of Survival

Independent predictors of overall, disease-specific and recurrence-free survival on multivariate analysis were:

1. Status of surgical margins
2. Histology
3. Extracranial extent

Complications

COMPLICATIONS OF CRANIOFACIAL RESECTION FOR MALIGNANT TUMORS OF THE SKULL BASE: REPORT OF AN INTERNATIONAL COLLABORATIVE STUDY

Ian Ganly, MD, PhD, Snehal G. Patel, MD, Bhuvanesh Singh, MD, Dennis H. Kraus, MD, Patrick G. Bridger, MD, Giulio Cantu, MD, Anthony Cheesman, MD, Geraldo De Sa, MD, Paul Donald, MD, Dan Fliss, MD, Patrick Gullane, MD, Ivo Janecka, MD, Shin-etsu Kamata, MD, Luiz P. Kowalski, MD, Paul Levine, MD, Luiz R. Medina, MD, Sultan Pradhan, MD, Victor Schramm, MD, Carl Snyderman, MD, William I. Wei, MD, Jatin P. Shah, MD
### Factors Associated with Complications

<table>
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<tr>
<th>Variable</th>
<th>Complication rate</th>
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<th>Multivariate analysis, relative risk (95% confidence interval)</th>
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<td>Age</td>
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<td>≤50 y</td>
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<tr>
<td>&gt;50 y</td>
<td>267/711 (38%)</td>
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<tr>
<td>Sex</td>
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<tr>
<td>Male</td>
<td>279/774 (36%)</td>
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<tr>
<td>Female</td>
<td>143/389 (37%)</td>
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<td>Prior radiation</td>
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<td>289/860 (34%)</td>
<td>.001</td>
<td>Reference 1.6 (1.2–2.0), p = .001</td>
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<td>Present</td>
<td>144/325 (44%)</td>
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<td>Dural invasion</td>
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<tr>
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<td>265/814 (33%)</td>
<td>&lt;.001</td>
<td>Reference 1.7 (1.3–2.2), p &lt; .001</td>
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<tr>
<td>Present</td>
<td>165/365 (45%)</td>
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<tr>
<td>Brain invasion</td>
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<td>Absent</td>
<td>389/1095 (36%)</td>
<td>.018</td>
<td>Reference 1.7 (1.1–2.7), p = .019</td>
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<td>Present</td>
<td>41/84 (49%)</td>
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<th>Overall complications, %</th>
<th>Wound, %</th>
<th>CNS, %</th>
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<td>Kraus</td>
<td>1994</td>
<td>85</td>
<td>2</td>
<td>39</td>
<td>24.7</td>
<td>17.6</td>
<td>5.9</td>
<td>4</td>
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<td>Dias</td>
<td>1999</td>
<td>104</td>
<td>7.6</td>
<td>48.6</td>
<td>38.5</td>
<td>23</td>
<td>10.6</td>
<td>5.8</td>
</tr>
<tr>
<td>Donald</td>
<td>1999</td>
<td>107</td>
<td>5.6</td>
<td>50.5</td>
<td>22.4</td>
<td>15.9</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Solero</td>
<td>2000</td>
<td>168</td>
<td>4.7</td>
<td>29.7</td>
<td>4.8</td>
<td>20.2</td>
<td>—</td>
<td>1.8</td>
</tr>
<tr>
<td>Mean</td>
<td>809 total</td>
<td>3.6</td>
<td>42.7</td>
<td>19.6</td>
<td>15.8</td>
<td>8.2</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>Present study</td>
<td>1193 total</td>
<td>4.7</td>
<td>36.3</td>
<td>19.8</td>
<td>16.2</td>
<td>4.8</td>
<td>1.7</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: CFR, craniofacial resection; CNS, central nervous system.
Benefits from the International Collaborative Study

• Benchmark outcomes data are now available from across the world
• Factors impacting upon outcomes are identified by multivariate analysis
• Case selection is made possible for better outcomes
• Outcomes from future interventions will have to be compared with these data.
35 Years in Skull Base Surgery

Entry in SBS
Technical Refinements
Early Experience
Realities & Frustrations
Morbidity/Outcomes - QOL
Ethics
Antibiotics Trial
Int’l Collaborative Study
Benchmark data
Leadership
President - NASBS
Wisdom

1977
1970s – 1980s
1990 - 2000
1996
1998
2000
2005
Progress in Skull Base Surgery

Issues / Wisdom

Case selection
Cost effectiveness
Economics
Ethics

Biology of the tumor
Quality of life
Disadvantages of External Skull Base Surgery

- External incisions
- Need for a craniotomy
- Morbidity and complications
- Cost (Length of Hospitalization)
- Esthetic and functional outcomes
- Quality of life
How to reduce the Morbidity of External Skull Base Surgery
Advantages of Endonasal Skull Base Surgery

- Avoids external incisions
- No esthetic sequela
- Avoids Craniotomy
- Reduced blood loss
- Total tumor resection possible
- Dural repair possible
1,500 + Patients

- Paranasal Sinus Tumors
  - 11% T1 or T2 – 21% No orbital or cranial involvement
- Esthesioneuroblastoma
  - 22% Kadish A – 40% no orbital or cranial involvement
- Low Grade Sarcoma
  - 10% T2 – 35%
- High Grade Sarcoma
  - 25% T2 – 23%
Site of Failure

LOCAL

REGIONAL

DISTANT

No failure = 86 (51%)
Local Recurrence is the most common cause of treatment failure

**Outcome**

**Prevention**

- Case Selection
- Favorable histology
- Monobloc resection
- Secure negative margins
- Post operative R.T.
Endonasal Endoscopic Surgery for Malignant Tumors Involving the Skull Base

-- Issues of Concern

-- Safety
  • Operative
  • Oncologic

Expertise
  • Learning Curve

Case Selection
  • Anatomic Extent
  • Histology
  • Biology
# 35 Years in Skull Base Surgery

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>Entry in SBS</td>
</tr>
<tr>
<td>1970s - 1980s</td>
<td>Early Experience</td>
</tr>
<tr>
<td>1990 - 2000</td>
<td>Enthusiasm</td>
</tr>
<tr>
<td>1990 - 2000</td>
<td>Technical Refinements</td>
</tr>
<tr>
<td>1996</td>
<td>Realities &amp; Frustrations</td>
</tr>
<tr>
<td>1996</td>
<td>Morbidity/Outcomes - QOL</td>
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<tr>
<td>1996</td>
<td>Ethics</td>
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<td>1998</td>
<td>Antibiotics Trial</td>
</tr>
<tr>
<td>2000</td>
<td>Int'l Collaborative Study</td>
</tr>
<tr>
<td>2005</td>
<td>Benchmark data</td>
</tr>
<tr>
<td>2017</td>
<td>Leadership President - NASBS</td>
</tr>
<tr>
<td>2017</td>
<td>Teaching, Training, Refining, Advancing, Adapting and Exploring</td>
</tr>
</tbody>
</table>

Wisdom

Pearls gathered over 35 years in Skull Base Surgery For Malignant Tumors

Case Selection (Endonasal resection)
Select Histology
Wide resection (Dura, Brain?, Orbit, Bone)
Secure margins
Dural repair / graft
Reconstruction with free flaps
Time tested techniques
Outcomes data available
ICSG for CFS
Conclusions

• CFR is a safe and effective treatment option for malignant skull base tumors.

• Histology of the primary tumor, its intracranial extent and status of surgical margins are independent predictors of RFS, OS and DSS.

• Future role of Endoscopic Approaches still in development and we must be diligent to monitor progress using this approach.
Choosing the Right Approach

ENDOSCOPIC APPROACH

NASAL CAVITY TUMORS
ETHMOID TUMORS
SKULL BASE EROSION

DURAL DISEASE INVASION

MAXILLARY SINUS TUMORS
ORBITAL INVASION
PALATE INVASION
NASAL BONE INVASION
SKIN/SOFT TISSUE

OPEN APPROACH
Choosing the Right Approach

- Endoscopic Approach
  - Nasal Cavity Tumors
  - Ethmoid Tumors
  - Skull Base Erosion

- Open Approach
  - Maxillary Sinus Tumors
  - Orbital Invasion
  - Palate Invasion
  - Nasal Bone Invasion
  - Skin/Soft Tissue

courtesy John de Almeida
OPEN CRANIOTOMY

ENDOSCOPIC
Analysis of Best Approach Within Each Region

When to use Endoscopic or Open Resection? Controversial and Revolutionary
“The future just ain’t what it used to be”
Mark Twain
• “It has become appallingly obvious that our technology has exceeded our humanity.”

Albert Einstein
Endoscopic surgery for malignant tumors of the sinonasal tract and adjacent skull base: A 10-year experience

Piero Nicolai, M.D.,* Paolo Battaglia, M.D.,# Maurizio Bignami, M.D.,# Andrea Bolzoni Villaret, M.D.,* Giovanni Delù, M.D.,# Tarek Khrais, M.D.,§ Davide Lombardi, M.D.,* and Paolo Castelnuovo, M.D.#

Conclusion: To the best of our knowledge, this is the largest series reported to date of malignant tumors of the sinonasal tract and adjacent skull base treated with pure endoscopic or craniendoscopic techniques. A 5-year disease-specific survival of 91.4% and 58.8% for the EEA and the CEA groups, respectively, seem to indicate that endoscopic surgery, when properly planned and in expert hands, may be a valid alternative to standard surgical approaches for the management of malignancies of the sinonasal tract.

# Histology

<table>
<thead>
<tr>
<th>Histology</th>
<th>EEA</th>
<th>CEA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n = 134)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>44</td>
<td>24</td>
<td>68</td>
</tr>
<tr>
<td>Squamous cell carcinoma*</td>
<td>16</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>Olfactory neuroblastoma</td>
<td>19</td>
<td>3</td>
<td>22</td>
</tr>
<tr>
<td>Mucosal melanoma</td>
<td>14</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Adenoid cystic carcinoma</td>
<td>12</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Hemangiopericytoma</td>
<td>8</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Lymphoproliferative</td>
<td>6</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>SNUC</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Chondrosarcoma</td>
<td>3</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Ewing’s sarcoma</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Neuroendocrine carcinoma</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Triton tumor</td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Ectomesenchymoma</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fibrosarcoma</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Giant cell tumor</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Leiomyosarcoma</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Malignant schwannoma</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Myofibrosarcoma</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Oncocytic carcinoma</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Osteosarcoma</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Secondary tumor</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Synovial sarcoma</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><em>This group includes conventional squamous cell carcinoma (23 cases), basaloid carcinoma (1 case), and transitional cell carcinoma (1 case).</em></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Follow Up & Recurrence

#### Table 4 Follow-up status of the patients

<table>
<thead>
<tr>
<th></th>
<th>EEA (n = 134)</th>
<th>CEA (n = 50)</th>
<th>Total (n = 184)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NED</td>
<td>121 (90%)</td>
<td>28 (56%)</td>
<td>149 (80.9%)</td>
</tr>
<tr>
<td>AWD</td>
<td>5 (3.8%)</td>
<td>3 (6%)</td>
<td>8 (4.4%)</td>
</tr>
<tr>
<td>DOC</td>
<td>2 (1.6%)</td>
<td>2 (4%)</td>
<td>4 (2.2%)</td>
</tr>
<tr>
<td>DOD</td>
<td>5 (3.8%)</td>
<td>16 (32%)</td>
<td>21 (11.4%)</td>
</tr>
<tr>
<td>Lost</td>
<td>1 (0.8%)</td>
<td>1 (2%)</td>
<td>2 (1.1%)</td>
</tr>
</tbody>
</table>

_NED = no evidence of disease; AWD = alive with disease; DOC = dead of other causes; DOD = dead of disease._

#### Table 6 Recurrence rate in relation to histology

<table>
<thead>
<tr>
<th>Histology</th>
<th>EEA (n = 25)</th>
<th>CEA (n = 18)</th>
<th>Recurrence Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epithelial neoplasms</td>
<td>12</td>
<td>13</td>
<td>25/111 (23)</td>
</tr>
<tr>
<td>ADC</td>
<td>6</td>
<td>8</td>
<td>14/68 (20)</td>
</tr>
<tr>
<td>SCC</td>
<td>3</td>
<td>4</td>
<td>7/25 (28)</td>
</tr>
<tr>
<td>ACC</td>
<td>2</td>
<td>—</td>
<td>2/13 (15)</td>
</tr>
<tr>
<td>SNUC</td>
<td>1</td>
<td>1</td>
<td>2/5 (40)</td>
</tr>
<tr>
<td>Melanoma</td>
<td>9</td>
<td>2</td>
<td>11/17 (65)</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>3</td>
<td>2</td>
<td>5/34 (15)</td>
</tr>
<tr>
<td>ONB</td>
<td>1</td>
<td>1</td>
<td>2/22 (9)</td>
</tr>
</tbody>
</table>

_ADC = adenocarcinoma; SCC = squamous cell carcinoma; ACC = adenoïd cystic carcinoma; SNUC = sinonasal undifferentiated carcinoma._
Future of Skull Base Oncology

“The best way to predict the future is to invent it.”

Alan Kay
Multidisciplinary Team Approach
Our Future - Read the Book – A brief history of To-Morrow.