Endoscopic procurement of tympano-ossicular allografts

impact on donation and transplantation

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Kennis / Ervaring / Zorg

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- Advantages and challenges of new technique
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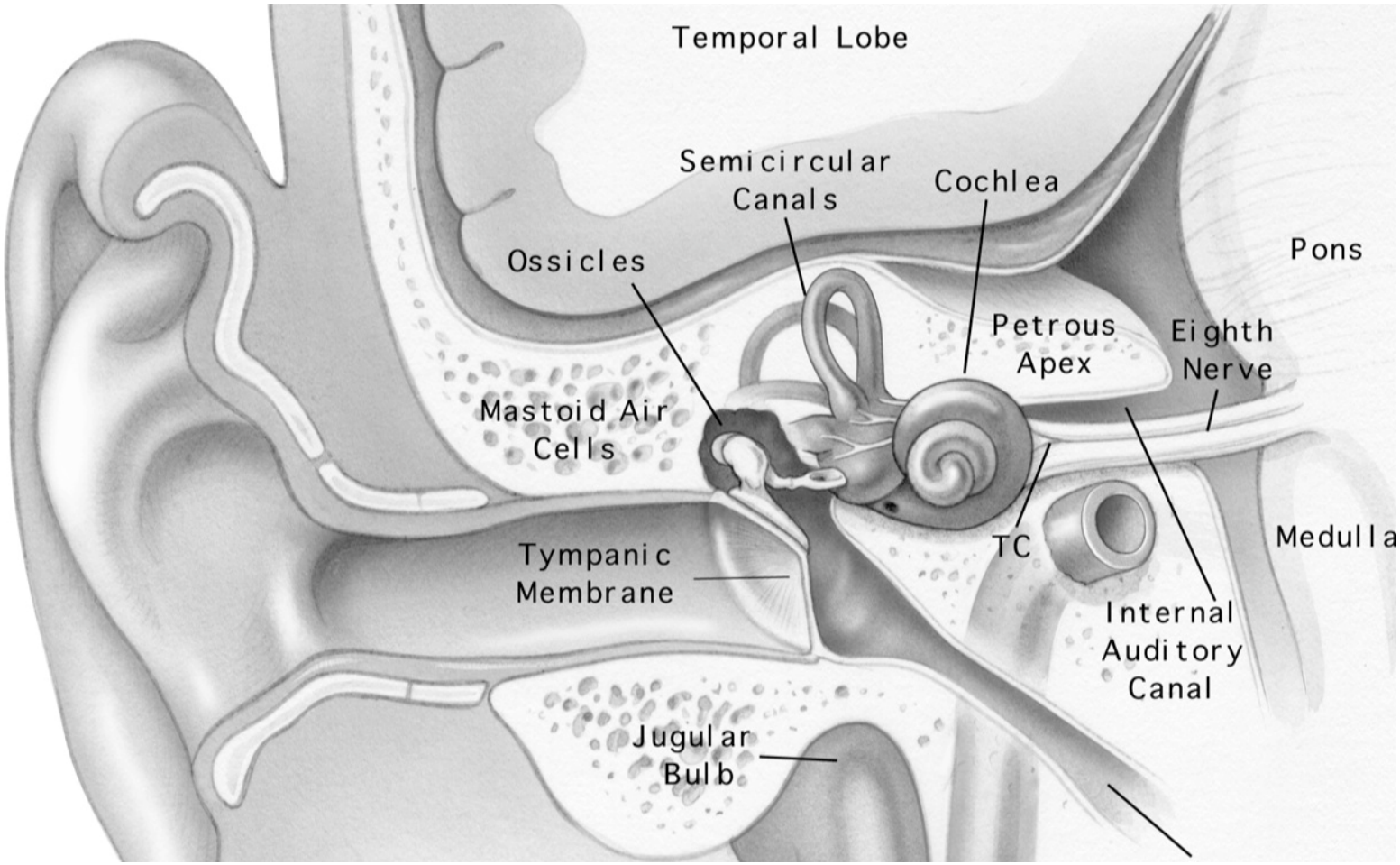
Anatomy of the ear



Chronic otitis media

- Chronic otitis media => perforation of the tympanic membrane => surgical reconstruction

Chronic otitis media

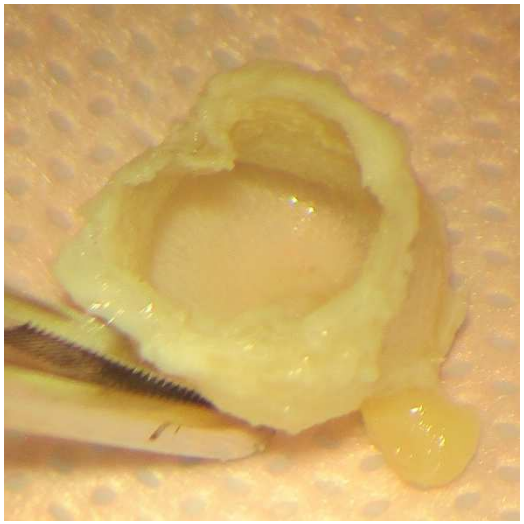
- Chronic otitis media => erosion or fixation of the ossicles => reconstruction of ossicular chain movement

Chronic otitis media

- Chronic otitis media => cholesteatoma => reconstruction of the external auditory canal, tympanic membrane and ossicular chain movement

Tympano-ossicular allografts

- Tympanic membrane with malleus attached

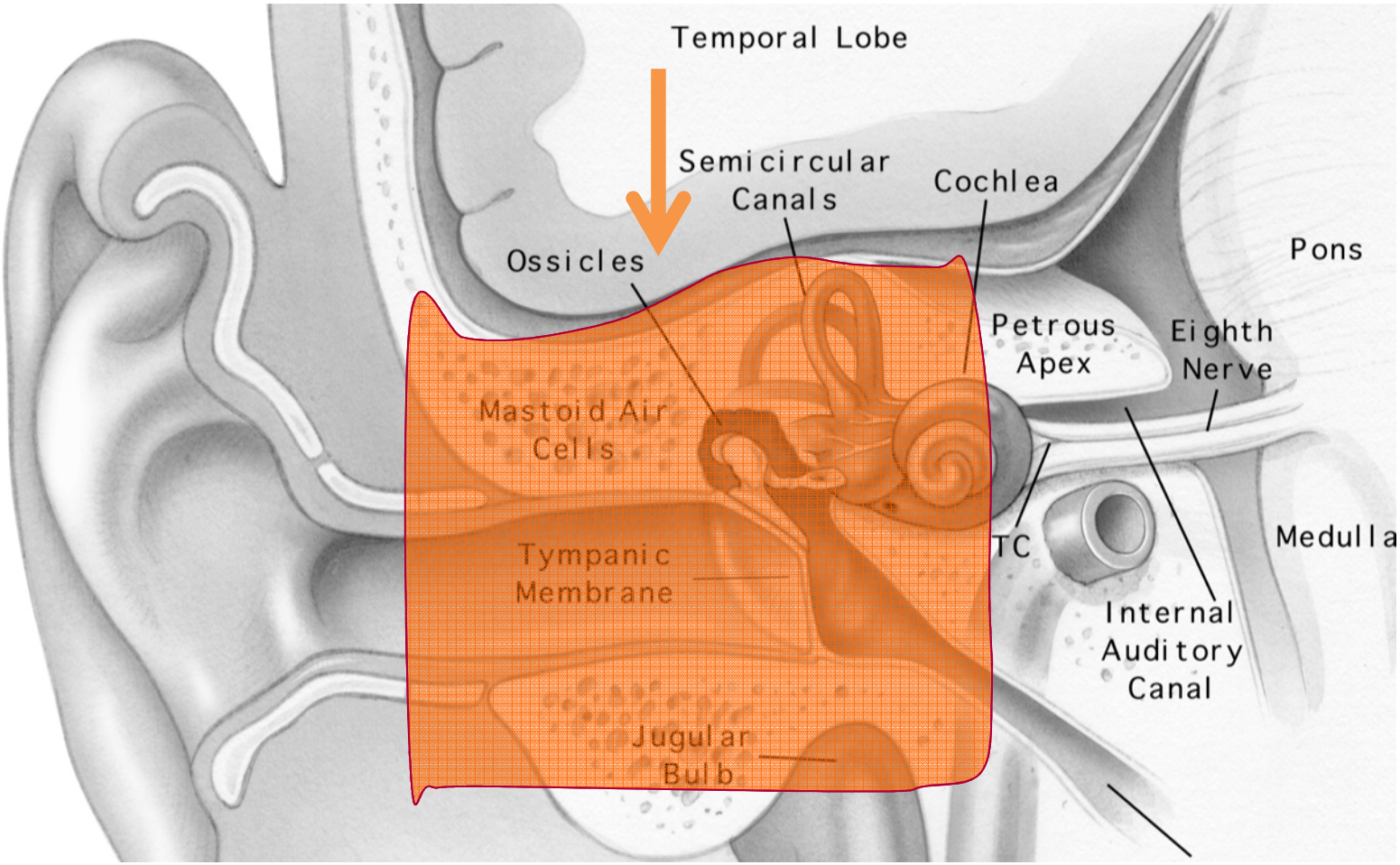


- Separate incus

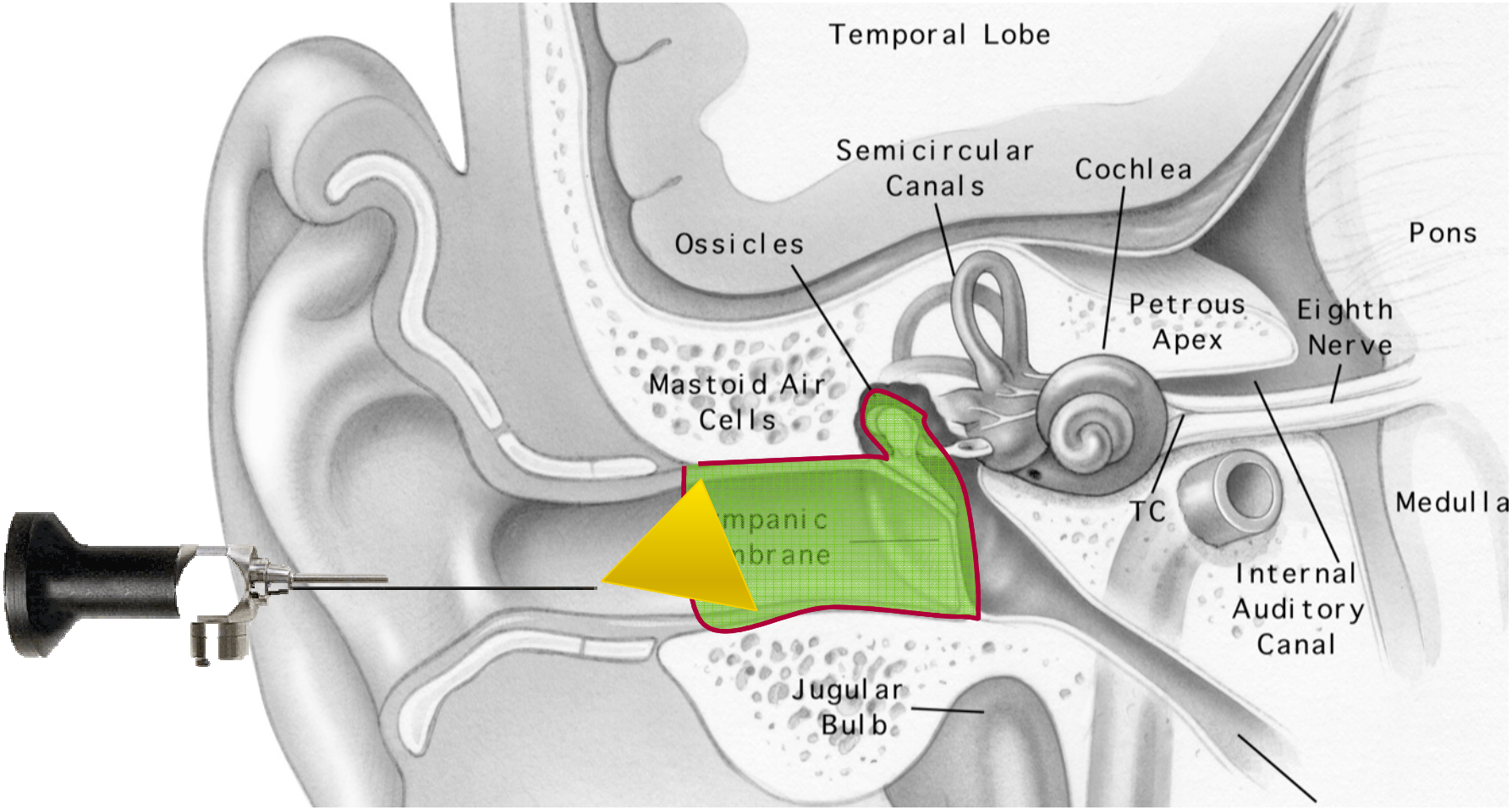
History

- 1959: Christian Betow — Berlin
  - First *en bloc* tympanomeatal transplantation
- 1961: Alfred Tobeck — Dortmund
  - First report of stapes transplantation
- 1964: Ned Chalat — Detroit
  - First report of pars tensa transplantation
- 1965: William House — Los Angeles
  - First report of incus transplantation
- 1966: Jean Marquet — Antwerp
  - First report of successful pars tensa transplantation

Until 2013: Transcranial procurement
Schuknecht bone plug technique



From 2013: Transmeatal procurement
Endoscopic technique



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Endoscopic procurement

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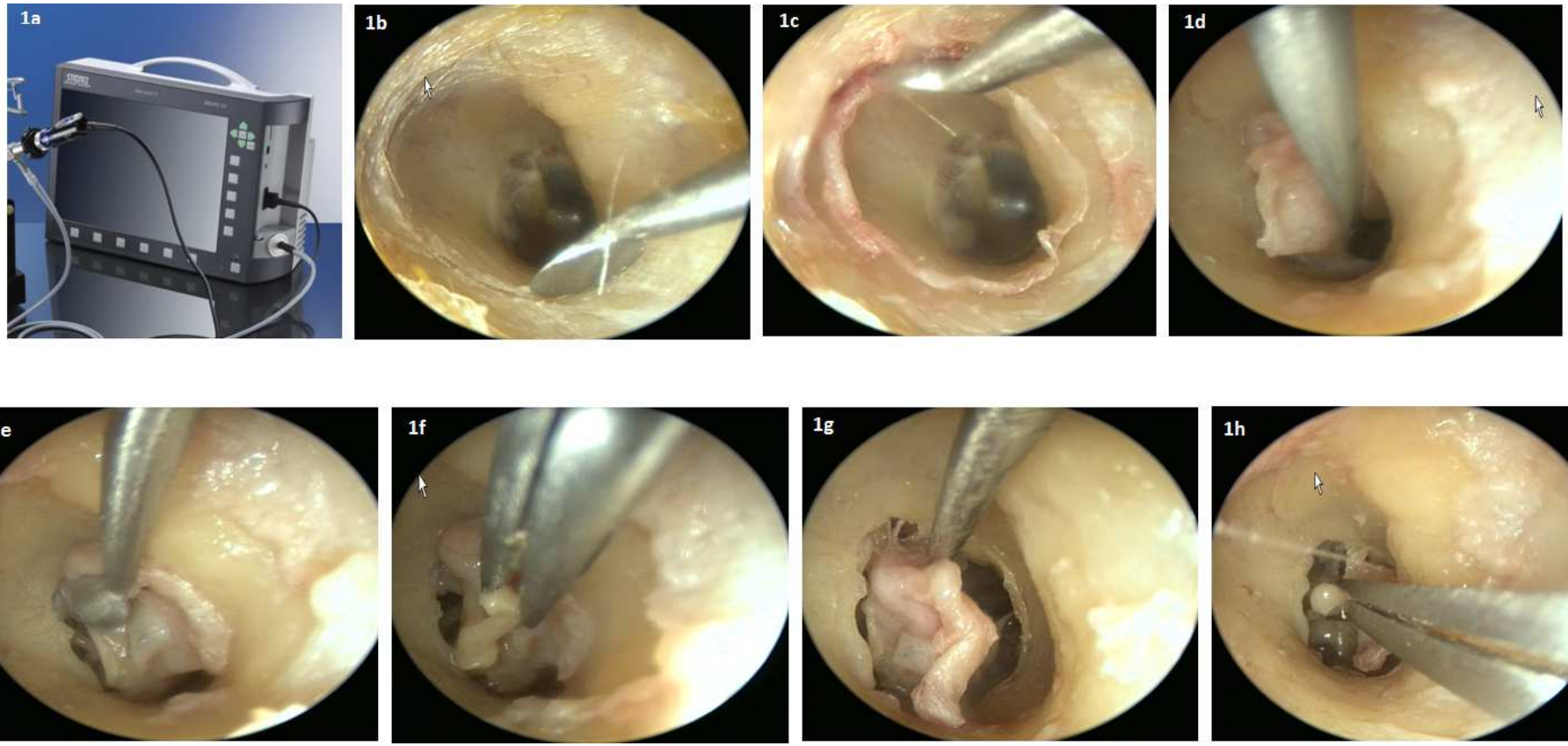

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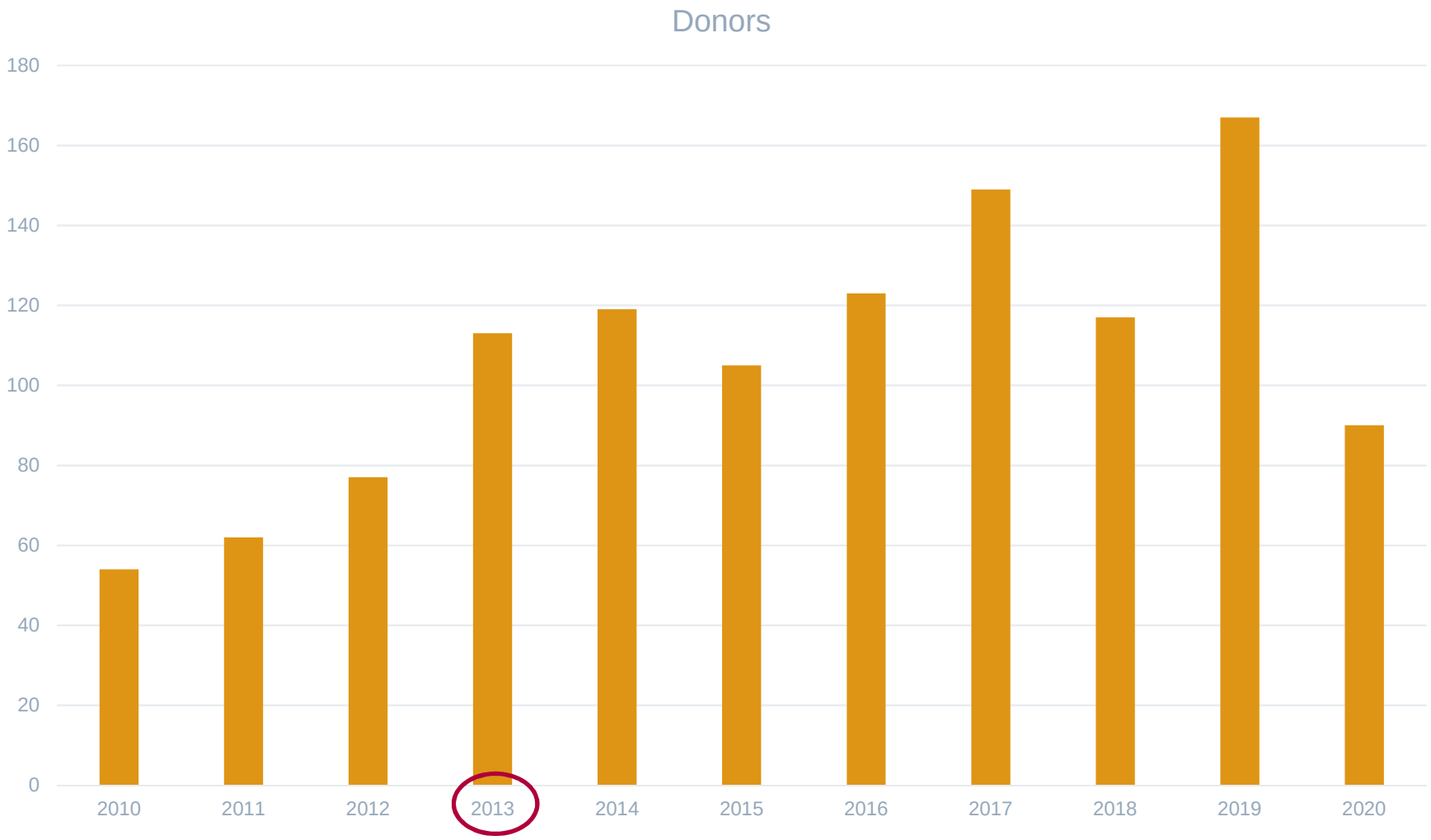
Increase in donor volume



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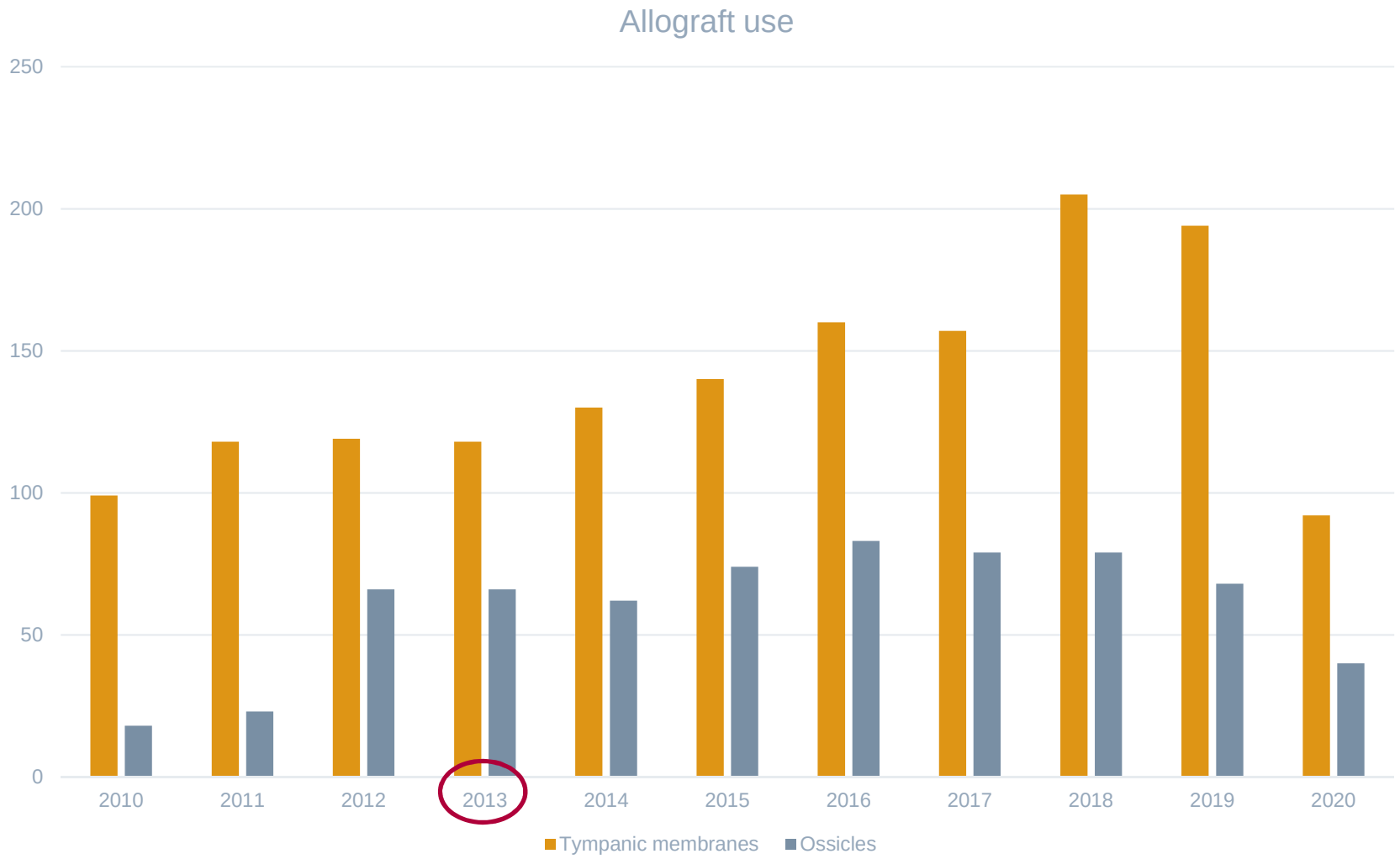
Increase in allograft use



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Donor volume vs. quality of allografts

- Quality of endoscopically procured allografts:
  - Ossicles: nearly always good quality, no difference with old technique
  - Ear drum allografts:

Period	2010-2012	2015-2019
Procurement technique used	Only transcranial	Only endoscopic
% grade 1 quality	63%	50% (-13%)
Grade 1 allografts / year	73	107 (+48%)

Waiting list:	end 2013:	3-6 months
	end 2016:	0-1 months
	now:	0-3 months (increased demand)

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Advantages of the endoscopic technique

- Not invasive
  - No incision needed over the head of the donor
  - No reconstruction needed
  - Amount of donors ↑
- Safe
  - No dura mater contact
  - Risk for transmission of prions ↓
- Time gain
  - Procurement of end product, no dissection step
  - Procurement time ↓

Tympano-ossicular allograft

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Challenges of the endoscopic technique

- Need for new material
  - 30° nasal endoscope (18 cm x 4 mm)
  - Monitor with light source and camera head (Storz Telepack)
  - Instruments for middle ear surgery (Rosen knife, Marquet decollator, microforceps, Fisch dissector)
- Steep learning curve
  - Experience in middle ear surgery or dissection of ATOS from a temporal bone plug are advantages
- Shape of the allograft after procurement
  - Before fixation in formaldehyde: relax graft in air and in physiological solution
- Difficulties in case of bleeding in ear canal (visibility) and in case of strongly curved ear canal (access)

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2014: prospective double-blind study

- 50 patients who underwent allograft tympanoplasty
  - 34 received endoscopically procured allografts (group A)
  - 16 received transcranially procured allografts (group B)
- Clinical outcome at 3 months postop:
  - Main outcome = ear drum intact
    - Secondary outcomes: no myringitis, no anterior blunting
- Group A: 1 reperforation, 1 case of anterior blunting
- Group B: no adverse events
- 1 patient lost to follow-up (group A)
- No statistically significant difference between both groups

Conclusion: both techniques have equivalent clinical outcome

Jeroen Caremans, Evert Hamans, Ludo Muylle, Paul Van de Heyning, Vincent Van Rompaey.
Endoscopic versus transcranial procurement of ATOS: a prospective double-blind randomized controlled audit
Cell & Tissue Banking 2016; 17(2): 199-204.

2014-2018: retrospective study

- Patients who underwent allograft tympanoplasty without cholesteatoma
- All received endoscopically procured allografts
- Same criteria checked at 3 months and 12 months postop

Jeroen Caremans, Paul Van de Heyning, Vedat Topsakal, Manon Huizing, Vincent Van Rompaey.
Endoscopic procurement of allograft tympano-ossicular systems: a retrospective audit on clinical outcome in 129 patients
Not published results

2014-2018: retrospective study: results

Process step	n	(%)
Notifications of decease	9434	
Donors	617	(6,5%)
Allografts (ear drums) procured	1049	
Allografts qualified	1031	
Allografts of good quality	765	(74,2%)
Allografts used	663	
In other hospitals	425	(64,1%)
In our hospital	238	(35,9%)
Tympanoplasty with cholesteatoma	102	(42,9%)
Tympanoplasty without cholesteatoma	136	(57,1%)
Patients with 3m follow up	129	(95%) ←
3m postop: intact allograft	110 →	(85,3%)
3m postop: reperforation	10	(7,8%)
3m postop: myringitis	6	(4,7%)
3m postop: anterior blunting	3	(2,3%)
Patients with 12m follow up	62	(48,1%) ←
12m postop: intact allograft	52 →	(83,9%)
12m postop: reperforation	7	(11,3%)
12m postop: myringitis	2	(3,2%)
12m postop: anterior blunting	1	(1,6%)
Patients with 3m audiological data	82	(63,6%) ←
Patients with 12m audiological data	60	(46,5%) ←

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2020: literature study

- Virucidal activity of formaldehyde solution used for preservation of tympano-ossicular allografts
  - Multiple studies show that a lower concentration of formaldehyde than the one used for preservation of tympano-ossicular allografts, inactivates a high amount of **HIV** at 4°C or at room temperature.
  - Human serum loaded with **HBV** or **HCV**, which had been treated with a very low concentration of formaldehyde, administered to chimpanzees, did not infect the animals.
  - As **SARS-CoV-2** is a relatively new virus, evidence on the effect of formaldehyde treatment is lacking, but multiple authors found that low concentrations of formaldehyde are effective in inactivating closely related coronaviruses like SARS-CoV and MERS-CoV, indicating a similar effect on SARS-CoV-2.
  - Even a complex virus like vaccinia loses its infectivity by exposure to formaldehyde at the concentration, temperature and exposure time used for the preservation of tympano-ossicular allografts.

Caremans J, Valgaeren H, Muylle L, Huizing M, Van Rompaey V. Virucidal activity of formaldehyde solutions used for preservation of allograft tympano-ossicular systems. B-ENT 2020; 16(4): 202-8.

Safety of tympano-ossicular allografts

- Virucidal activity of formaldehyde solution (literature study)
- Study in 5 donors who died of AIDS: no viral DNA detected after preservation of allografts in formaldehyde (Janssens-de Varebeke 1998)
- Antimicrobial effect of formaldehyde solution (formal validation in 2010)
- No dura mater contact in endoscopic procurement, so no risk of CJD transmission
- No reported cases of disease transmission
- Regulatory framework, meticulous donor screening, serological tests, NAT tests

➔ very safe reconstruction material

Caremans J, Valgaeren H, Muylle L, Huizing M, Van Rompaey V. Virucidal activity of formaldehyde solutions used for preservation of allograft tympano-ossicular systems. B-ENT 2020; 16(4): 202-8.

Conclusion

- Endoscopic procurement technique is esthetically less invasive, safer and faster than the transcranial procurement technique
- Both techniques have equivalent clinical outcome at 3 months post-op (prospective study)
- Retrospective study shows an intact ear drum without myringitis or anterior blunting at 3 months post-op in 85% of the cases where endoscopically procured allografts have been used

~~Transcranial technique~~ → Endoscopic technique