**continental preferences in reconstruction of pharyngolaryngectomy defects: A multi-national survey**

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# *Key Points*

Question: Is there variation in the types of reconstruction performed for total pharyngolaryngectomy defects in different continents?

Findings: This original survey study shows that pedicle flap reconstruction is most routinely performed by surgeons in India and Bangladesh (57.7%) compared to surgeons in North America and Australia/New Zealand where free flap reconstruction is preferred.

Meaning: Nation of practice plays a key role in determining reconstructive algorithm for surgeons when repairing total pharyngolaryngectomy defects.

# *Abstract*

Background: Reconstruction of total pharyngolaryngectomy defects may restore pharyngeal function and enable tracheoesophageal speech yet after oncological resection of locoregionally advanced malignancy. Reconstructive techniques most widely performed are free flap reconstruction and pedicle flap reconstruction. The indications, complications and outcomes of these techniques have been well described. However, little is known about variation in the practices and preferences of surgeons across differing global regions.

Method: A survey was sent to reconstructive head and neck surgeons in America, Australia, Canada, India, Bangladesh and New Zealand with responses analysed to evaluate trends. Data analysed included demographic details for individual surgeons as well as usual practices in the reconstruction of pharyngolaryngectomy defects.

Results: 155 individuals opened the survey with a completion rate of 79.4% (n=123). 74 respondents (60.2%) were from North America (USA and Canada), 26 (21.1%) from the Indian Subcontinent (India and Bangladesh) and 23 (18.7%) from Australia and New Zealand. A high rate of attrition was observed amongst surgeons trained in pedicle flap reconstruction, with only 47.5% performing these procedures after completion of training. However, pedicle flaps were most routinely performed by surgeons from the Indian subcontinent. The anterolateral thigh flap was most popular amongst surgeons when performing free flap reconstruction 58.5% (n=72).

Conclusion: This study demonstrates significant region-based variation in preferred reconstructive modality. This suggests that location of practice, institutional experience and location of training influence the reconstructive algorithms of individual head and neck surgeons.

Key Words: Pharyngolaryngectomy, Reconstruction, Survey, Free Flap, Pedicle Flap, Country, Surgical Training.

# *Background*

Total pharyngolaryngectomy involves complete resection of the larynx and adjacent hypopharynx for locoregionally advanced malignancy. This procedure remains reserved for laryngeal lesions with extension to the pyriform sinus or lateral pharyngeal wall and hypopharyngeal tumours involving significant circumferential extent of the hypopharynx and extending to the larynx or base of tongue1-4. Total pharyngolaryngectomy provides favourable survival outcomes in primary and salvage settings for advanced hypopharyngeal and laryngeal malignancy5,6. 2 and 5 year disease-specific survival rates for hypopharyngeal squamous cell carcinoma are around 72% and 52% respectively following resection2. However, this procedure incurs significant postoperative complications including bleeding, infection, neopharyngeal stricture and pharyngocutaneous fistula7-12. Recovery is also limited by post-operative speech and swallowing impairment and mental health concerns12-15.

Pharyngolaryngectomy radically alters native aerodigestive anatomy, creating discontinuity between oropharynx and cervical oesophagus1. Permanent tracheostomy and pharyngeal reconstruction are thus required to preserve continuity of the aerodigestive tract to facilitate breathing, swallowing and tracheoesophageal speech16,17. Reconstructive techniques aim to re-create a functional tube, restoring sensory circuits and propulsive forces of the hypopharynx enabling swallowing and phonation18. Techniques to reconstruct such defects predominantly include pedicle flap reconstruction (PFR) and free flap reconstruction (FFR). FFR is widely perceived as the first choice for pharyngolaryngectomy reconstruction. Despite requiring microvascular anastomosis, FFRs are diverse including enteric free flaps such as free jejunal transfer (FJT) or fasciocutaneous free flaps using the anterolateral thigh (ALT) or radial forearm (RF) as donor sites. In contrast, PFR does not require microvascular anastomosis and is preferred in vasculopaths or patients with free-flap failure19. These flaps incur significant donor site morbidity with functional shoulder girdle muscle transposed to the neck.

Surgical reproducibility, flap reliability, low complication rates, low donor site morbidity and reassuring functional outcomes remain critical goals of pharyngeal reconstruction in both the primary and salvage case20,21. However, at present, there are essentially no reconstructive options that fully encompass each of these criteria8. Hence, a myriad of patient, flap, functional and defect factors influence the choice of reconstruction by surgeons. Richmon et al.’s 2009 survey of American reconstructive surgeons, found that when repairing pharyngolaryngectomy defects, otolaryngology trained surgeons valued functional outcomes more than surgeons trained in Plastic Surgery, suggesting discipline of training influences choice of procedure22. A survey by Kovatch et al. found significant variation amongst American reconstructive surgery departments regarding the preferred type of flaps in head and neck reconstruction and flap monitoring techniques, indicating that institutional preference also determines reconstructive choices23. Within the broader surgical world, fellowship completion, case load, nation of practice and procedure cost have all been described as significant features with regards to surgical decisions and outcomes24,25. There currently exists a lack of literature exploring how reconstructive practices in total pharyngolaryngectomy reconstruction varies based on nation of surgical practice. This paper aims to address this deficit in the existing literature.

# *Method*

*Inclusion and exclusion criteria.*

All surgeons trained and practising in head and neck reconstruction at a consultant/attending or equivalent level were included from six nations of interest (Canada, United States of America [USA], New Zealand, Australia, India and Bangladesh. Currently-practicing surgeons trained in all disciplines could participate, including otolaryngologists, plastic surgeons, general surgeons, and maxillofacial surgeons. Individuals who did not meet these criteria were prohibited from completing the survey. Any respondent who did not meet the inclusion criteria or who did not complete more than 65% of the survey was excluded from the data.

*Survey Design*

A web-based survey was designed using the Survey Monkey platform (San-Mateo, California, USA). The survey consisted of 25 questions, divided into 6 sections. Survey completion was anonymous, however some institutional and personal details were elicited to validate response legitimacy26. Questions were designed to avoid acquiesce bias, a tendency to agree with socially acceptable statements and collection of categorical data was prioritised, where possible to increase response accuracy23,27. The survey was designed in accordance with codes of ethics and standard in survey research by the American Association of Public Opinion Research (AAPOR)28. Finally, the survey was reviewed by Australian, Indian, and American surgeons to guarantee accessibility of the survey’s terminology across a range of nations. St Vincent’s Hospital, Human Research Ethics Committee (2020/ETH01857) approved this study.

*Survey Distribution*

In Australia and New Zealand, the survey was distributed through the Australian Plastics Society and the Australian and New Zealand Society of Head and Neck Cancer Surgery. This was justified on the grounds that Australian reconstructive head and neck surgeons are spread throughout many centres and no individual society represents this heterogenous group29. In the United States of America (USA), Canada and the Indian subcontinent, heads of departments at high-volume reconstruction centres were recruited to engage their attending staff. This was feasible given these healthcare systems often promote subspecialisation of institutions into high-volume centres. The Canadian Society of Otolaryngology Head and Neck Surgery (CSOHNS) was also engaged for dissemination of the survey to their constituents.

*Outcome Measures*

The primary outcomes of this survey included differences preferences in reconstructive choices for repair of pharyngolaryngectomy defects. Other primary outcomes included demographic factors on surgical training and fellowship completion.

*Data Analysis*

Statistical analysis involved a combination of Graph Pad Prism V8.4.3 (La Jolla, CA) and IBM SPSS Statistics V26.0 (SPSS Inc., Chicago, IL). Categorical data was analysed using the Chi-square and Fisher’s exact test when assumptions of the Chi-square test pertaining to expected counts were violated. The Freeman-Halton extension of Fisher’s exact test was used to analyse categorical data with more than two variables. Statistical significance was considered for all tests which considered p<0.05. Given population disparities impacting group power, responses were grouped into three regions; North America (NA) (Canada and USA), Australia/New Zealand (ANZ) and the Indian Subcontinent (IS) – India and Bangladesh.

# *Results*

155 participants opened the survey. Of these, thirty-two responses were excluded as they did not fulfil inclusion criteria (no longer currently practicing, not from included country of practice, completed <65% of the survey). This equated to an 79.4% completion rate. Of the included participants (n=123), 97.6% completed the survey in its entirety (n=120).

*Descriptive Statistics*

Respondents from the USA were most numerous (n=46) with fewer respondents from Canada (n=28), India (n=24), Australia (n=22), New Zealand (n=1) and Bangladesh (n=1) (Table 1). Participants from these six nations spanned 84 different institutions. 85 surgeons were Otolaryngology-trained (69.1%) and 26 were trained in Plastic Surgery (21.1%). Remaining participants were trained in general surgery, maxillofacial surgery, surgical oncology, head and neck surgery and cardiothoracic surgery. There was statistically significant difference in the field of training by region (p<0.001), with North American (NA) surgeons and Indian subcontinent (IS) surgeons more likely to have been trained in otolaryngology compared to surgeons from ANZ.

79.7% of respondents (n=98) had a head and neck reconstructive case load of one or more case per week. However, there was no statistical difference in the gross case load amongst surgeons of differing regions (p=0.38). 81.3% (n=100) of respondents had completed a designated reconstructive head and neck fellowship (Table 1). The nation of fellowship completion demonstrated the USA was the most common nation of reconstruction completion (n=57), followed by Canada (n=15) (Table 2). Whilst most respondents indicated completion of a specific head and neck reconstruction fellowship, 7 respondents completed a designed microsurgery fellowship and 4 in facial plastics. US/Canadian surgeons were statistically more likely to have completed specific head and neck fellowships than ANZ, Bangladeshi and Indian counterparts (p<0.001).

Table 1. Summary of respondent descriptive data (percentage)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | North America - USA & Canada | Indian Subcontinent- India & Bangladesh | Australia & New Zealand | P Value |  |
| Number of surgeons (%) | | 74 (60.2) | 26 (21.1) | 23 (18.7) |  |  |
| Nation of practice (%) | |  |  |  |  |  |
|  | USA | 46 (37.4) |  |  |  |  |
|  | Canada | 28 (22.8) |  |  |  |  |
|  | India |  | 24 (19.5) |  |  |  |
|  | Bangladesh |  | 2 (1.6) |  |  |  |
|  | Australia |  |  | 22 (17.9) |  |  |
|  | New Zealand |  |  | 1 (0.8) |  |  |
| Number of institutions represented | |  |  |  |  |  |
|  | America | 24 |  |  |  |  |
|  | Canada | 21 |  |  |  |  |
|  | India |  | 19 |  |  |  |
|  | Bangladesh |  | 2 |  |  |  |
|  | Australia |  |  | 17 |  |  |
|  | New Zealand |  |  | 1 |  |  |
| Training Specialty (%) | |  |  |  |  |  |
|  | Otolaryngology | 61 (82.4) | 18 (69.2) | 6 (26.1) | *p<0.001* |  |
|  | Plastic Surgery | 13 (17.6) | 3 (11.5) | 10 (43.5) |  |  |
|  | General Surgery | 0 (0) | 1 (3.8) | 5 (21.7) |  |  |
|  | Maxillofacial Surgery | 0 (0) | 0 (0) | 2 (8.7) |  |  |
|  | Surgical Oncology | 0 (0) | 2 (7.7) | 0 (0) |  |  |
|  | Other | 0 (0) | 2 (7.7) | 0 (0) |  |  |
| Case Load (%) | |  |  |  |  |  |
|  | ≥ 1 case per week | 60 (81.1) | 22 (84.6) | 16 (69.6) | *p=0.380* |  |
|  | < 1 case per week | 14 (18.9) | 4 (15.4) | 7 (30.4) |  |  |
| Completed Head and Neck reconstruction fellowship (%) | |  |  |  |  |  |
|  | Yes | 70 (94.6) | 12 (46.2) | 18 (78.3) | *p<0.001* |  |
|  | No | 4 (5.4) | 14 (53.8) | 5 (21.7) |  |  |

Table 2. Country of fellowship completion

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Nation of surgical practice | | | | | | | |
| Nation of fellowship completion |  | USA (n=46) | Canada  (n=28) | India (n=24) | Bangladesh (n =2) | Australia  (n=22) | New Zealand (n=1) |
| USA | 40 | 13 | 1 |  | 3 |  |
| Canada | 1 | 10 |  |  | 4 |  |
| India |  |  | 10 |  |  |  |
| Australia |  | 1 |  |  | 3 | 1 |
| New Zealand |  | 1 |  |  | 2 |  |
| England |  |  | 1 |  | 5 |  |
| Other | 2 (Taiwan) | 1 (France)  1 (Netherlands) | 1 (France)  1 (Italy) |  |  |  |

Preferences and practices in pharyngolaryngectomy reconstruction by region

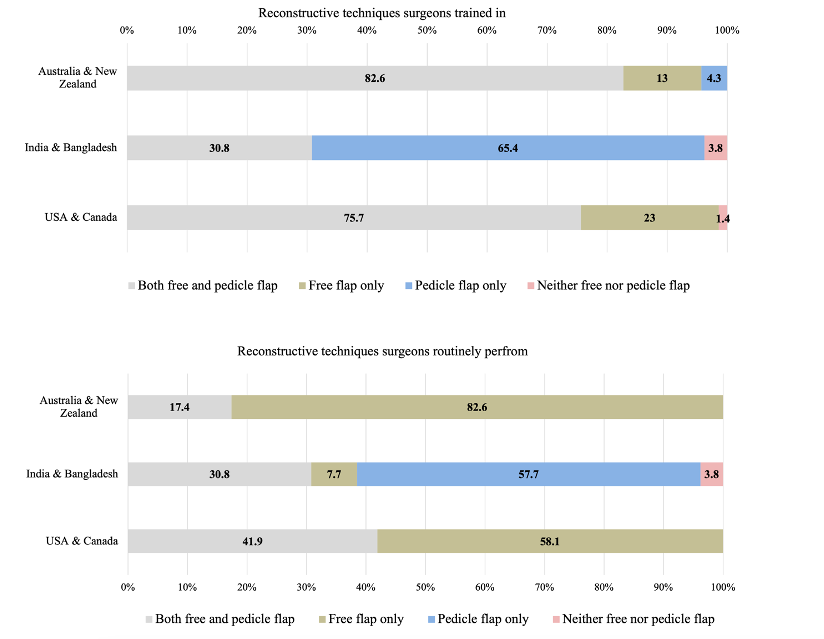
Of all respondents, 67.5% (n=83) were trained to perform free flap and pedicle flap reconstruction of total pharyngolaryngectomy defects. Whilst 75.7% of north american surgeons and 82.6% of ANZ surgeons, had trained in both PF and FF reconstruction, only 30.8% of surgeons in the Indian subcontinent had this training (p<0.001). Within the Indian subcontinent demographic, 65.4% of surgeons had only been trained in pedicle flap reconstruction during surgical training (Table 3).

When asked what procedure surgeons performed routinely, where routinely was defined as more than one case per year, only 34.5% of all respondents (n=43) indicated that they performed both PFR and FFR routinely. The Australia/New Zealand cohort indicated that 82.6% (n=19), only perform free flap reconstruction. No north american or ANZ surgeon only performed pedicle flap reconstruction routinely compared to 57.7% of surgeons practicing on the Indian subcontinent (Table 3, Figure 1, p<0.001). However, there weas no significant difference found between the three regions regarding frequency of use of preoperative vascular imaging (p=0.443), timing of flap raising (p=0.704) and perceived duration of procedure length (p=0.105) (Table 3).

Table 3. Preference in pharyngolaryngectomy reconstruction regarding timing of flap raising, preoperative vascular imaging, perceived procedure length and preferred free flap harvest site by region of surgical practice.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | North America (NA) - USA & Canada | Indian Subcontinent (IS)- India & Bangladesh | Australia & New Zealand (ANZ) | P value |
| What reconstructive techniques were you trained in? (%) | | |  |  |  |
|  | Both free and pedicle flap | 56 (75.7) | 8 (30.8) | 19 (82.6) | p<0.001 |
|  | Free flap only | 17 (23) | 0 (0) | 3 (13) |  |
|  | Pedicle flap only | 0 (0) | 17 (65.4) | 1 (4.3) |  |
|  | Neither free flaps nor pedicle flaps | 1 (1.4) | 1 (3.8) | 0 (0) |  |
| What reconstructive techniques do you routinely perform? (%) | | |  |  |  |
|  | Both free and pedicle flap | 31 (41.9) | 8 (30.8) | 4 (17.4) | p<0.001 |
|  | Free flap only | 43 (58.1) | 2 (7.7) | 19 (82.6) |  |
|  | Pedicle flap only | 0 (0) | 15 (57.7) | 0 (0) |  |
|  | Neither free flaps nor pedicle flaps | 0 (0) | 1 (3.8) | 0 (0) |  |
| Preferred site of free flap harvest (%) | | |  |  |  |
|  | ALT | 45 (60.8) | 12 (48) | 15 (65.2) | p = 0.027  NA v IS p=0.024  NA v ANZ p=0.024  IS v ANZ p=0.4016 |
|  | RF | 22 (29.7) | 5 (20) | 2 (8.7) |  |
|  | Jejunum | 7 (9.5) | 8 (32) | 6 (26.1) |  |
| At what point is flap harvesting performed in your institution? (%) | | |  |  |  |
|  | Synchronous | 59 (80.8) | 15 (88.2) | 17 (73.9) | p=0.704 |
|  | Even Mix | 11 (15.1) | 2 (11.8) | 4 (17.4) |  |
|  | Metachronous | 3 (4.1) | 0 (0) | 2 (8.7) |  |
| Do you routinely perform vascular imaging prior to head and neck reconstruction? (%) | | |  |  |  |
|  | No | 61 (82.4) | 17 (68) | 18 (78.3) | p=0.443 |
|  | Occasionally | 8 (10.8) | 4 (16) | 4 (17.4) |  |
|  | Yes | 5 (6.8) | 4 (16) | 1 (4.3) |  |
| Which reconstructive modality do you perceive as longer in duration? (%) | | |  |  |  |
|  | FF | 50 (68.5) | 21 (84) | 11 (50) | p=0.105 |
|  | PF | 2 (2.7) | 0 (0) | 2 (9.1) |  |
|  | Even | 21 (28.8) | 4 (16) | 9 (40.9) |  |

**Figure 1.** Reconstructive modality surgeons were trained to perform (above) compared to the reconstructive modality they routinely (>1 per year) perform (below)



Grouped analysis indicated significant difference (p=0.027) amongst the three cohorts in the preferred site of free flap harvest. Further subgroup analysis showed no statistical significance between ANZ and IS surgeons (p=0.4016), although there was difference between NA and IS surgeons (p=0.027) and NA and ANZ surgeons (p=0.024). In the IS and ANZ cohorts, a higher proportion of surgeons opted for FJT as their preferred FFR (32% and 26.1% respectively) compared to 9.5% of the North American cohort. Despite this, ALT flaps were universally the most preferred across all three regions (Table 3).

The most common explanation for surgeons preferring the ALT flap was “improved donor site morbidity” (n=44) whereas the main reason the jejunum flap and radial forearm were preferred due to their swallowing outcomes (Table 4). Respondents also had the opportunity to add alternative responses to justify their preferred FF which are listed in Table 4.

**Table 4.** Reasons for preference in free flap harvest site. Responses without quotation marks indicate standardised options. Responses with quotation marks reflect additional responses from respondents.

|  |  |  |
| --- | --- | --- |
|  | Reason for preference | Number of responses |
| ALT | | 72 |
|  | Less donor Site morbidity | 44 |
|  | Better Swallowing outcomes | 16 |
|  | Personal Comfort | 5 |
|  | “Larger flap size/ volume of transposed tissue (+/- for circumferential reconstruction” | 5 |
|  | “Post-operative flap monitoring” | 3 |
|  | “Variety of flaps for vessel and/or skin coverage (i.e. chimeric, double skin paddle, etc)” | 2 |
|  | “Option for reinforcement over suture line with fascia” | 1 |
|  | “Option for harvesting muscular tissue for further reinforcement, particularly in irradiated patients and vasculopaths” | 1 |
|  | "Speech quality" | 1 |
|  | "Shorter operative duration compared to latissimus pedicle flaps" | 1 |
|  | "Reliable pedicle length and vessel size" | 1 |
|  | "Superior healing" | 1 |
|  | “Preferable in thinner patients” | 1 |
| RF | | 29 |
|  | Improved swallowing outcomes | 14 |
|  | Personal comfort | 7 |
|  | Donor site morbidity | 2 |
|  | Flap reliability / lower failure rate | 4 |
|  | “Thin and pliable flap” | 2 |
|  | “Avoid bowel resection” | 1 |
|  | “Quick to raise” | 1 |
|  | “Can be sensate” | 1 |
|  | Low fistula rate | 1 |
| Jejunum | | 21 |
|  | Swallowing outcomes | 18 |
|  | Personal comfort | 1 |
|  | "Lack of additional suture line to tubularize the flap" | 1 |
|  | Flap reliability | 1 |
|  | Low complications | 1 |
|  | Low leak rate | 1 |
|  | “Ability to close the neck” | 1 |

# *DISCUSSION*

Various patient, donor site and defect features complicate the choice of preferred surgical modality in the reconstruction of total pharyngolaryngectomy defects. Further complicating this decision are the complications and functional outcomes for these differing procedures. Numerous algorithms guiding choice of reconstructive modality for pharyngolaryngectomy defects have been proposed. Both Balasubramanian et al.’s 2018 algorithm and Clark et al.’s 2006 algorithm uniformly reserve gastric pull up for situations with significant cervical oesophageal involvement where FFR and PFR may be limited12,30-32. Balasubramanian et al’s algorithm suggests use of both PFR and FFR for circumferential defects although does not propose a means of clinically distinguishing between these30. Conversely Clark et al.’s algorithm uses thigh thickness to determine use of tubed ALT or RFF for circumferential defects. However, this algorithm does not provide any scope for PFR techniques and reserves gasto-omental free flaps for salvage cases after chemoradiation where the omentum can be used to reinforce the conduit and minimise risk of fatal vessel rupture33. Another model proposed by Piazza et al. in 2017 further conflicts with existing decision trees12,34. This approach, also for reconstruction of circumferential hypopharyngectomy defects, relies on defect length and lower/upper limb vascular status to determine whether RF or ALT be used. This algorithm uniquely defines an indication for pedicle flap repair, in the context of hostile upper and lower limb vascularity or where concerns with patient compliance or donor site arise34. Ultimately, these algorithms all demonstrate preference for fasciocutaneous FFR, with enteric FFR or PFR reserved for situations where fasciocutaneous FFR is contraindicated35.

Despite the clinical relevance of each of these varying approaches to reconstruction of circumferential pharyngolaryngectomy defects, their heterogeneity reflects a lack of consistent variables which drive surgical decision making. This study further reinforces this idea, demonstrating nation of surgical practice significantly impacts the choices of reconstructive technique by surgeons. This study demonstrates that surgeons practicing in the Indian subcontinent were statistically more likely to have been trained in routinely performing pedicle flaps only (p<0.001). Unlike their counterparts in North America and ANZ, experience in free flap reconstruction during training was more limited, translating to a smaller proportion of surgeons performing free flap reconstruction as part of their regular practice (Figure 1). In contrast, 0% of either the NA or ANZ cohorts solely perform pedicle flaps in their regular practice with 82.6% of ANZ surgeons (n=19), in contrast, solely performing free flaps to reconstruct such defects (Table 3).

The explanation for this is likely multifactorial, reflecting patterns in training culture, hospital infrastructure, funding, and population demographics. Literature argues the primary disadvantages of PFR is that flaps require excessive time to achieve swallowing and have limited flexibility as they are tethered by the vascular territory of their pedicle thereby making PFR less suitable for complex defects8. However, FFR requires access to microsurgery and therefore requires human and physical infrastructure, instruments, equipment and training opportunities to facilitate sustainable intraoperative and post-operative flap care36. Although achievable, this process proves challenging in rural and other resource-limited environments36-39. Even in the US, patients living in rural environments are less likely to receive gold standard reconstructive care40. With 64% of the Indian population living in rural settings compared to 14% of the Australian and 44% of the US population, this posits one explanation for the prevalence pedicle flap reconstruction in the IS cohort41.

Further, this study reinforces the popularity of the ALT as the preferred free flap for reconstructing total pharyngolaryngectomy defects. 59% (n=72) of respondents indicated the ALT was their preference in this context (Table 3). Literature suggests that fasciocutaneous flaps (ALT and RFFF) have similar speech outcomes yet are limited by worse stricture rates compared to enteric flaps such as the FJT42. Although requiring abdominal entry, FJT is unique in that a vertical suture lines is not needed to tubularize the flap and its length may be adjusted to accommodate for defect size8,43. Although, the ALT proved most favourable, the North American cohort was statistically less likely to favour use of the FJT (vs ANZ p=0.024, vs IS p=0.024). Where 32% of IS and 26.1% of ANZ surgeons preferred this flap, only 9.5% of north american surgeons shared this preference Table 3). The practice of surgery largely involves direct transfer of knowledge and skill set from teacher to student. This means that cultural trends and institutional preferences tend to percolate through generations of surgeon. As such, the reduced preference for FJT amongst north american surgeon may reflect a cultural milieu differing from surgeons in Australia/New Zealand and the Indian subcontinent.

Whilst the ALT and RFFF are similar in their composition, the supremacy of the ALT lies in its versatility. The most common response justifying ALT use was “less donor site morbidity,” many surgeons added personal responses (Table 4). Responses demonstrated that surgeons appreciate the variety of obtained from ALTs (i.e. chimeric/double skin paddle flaps), the capacity for additional skin coverage, the reliability of pedicle length and vessel size, speech quality and the freedom to harvest muscular tissue as a second layer of reinforcement for vasculopaths and patients with extensive radiation damage. RFFFs were less popular amongst respondents as most surgeons seem to reserve the RFFF for cases where they wish to utilise a fasciocutaneous FFR, but excessive ALT thickness compromises the ability to tubularize the flap.

Finally, this survey demonstrates cultural differences in the practice and training of head and neck reconstructive surgery in three regions examined. Despite similar caseloads, there was significant variation in the disciplines of training amongst reconstructive surgeons. Whilst 82.4% of NA surgeons and 69.2% of IS surgeons were otolaryngology-trained, only 26.1% of ANZ surgeons were trained in otolaryngology (Table 2). In ANZ, the majority of surgeons (43.5%) were plastic surgery trained with significant influences from general surgery (21.7%) and maxillofacial surgery (8.7%). This reflects cultural differences whereby in America convention follows that the majority of head and neck surgery is performed by Otolaryngologists44,45. Further NA surgeons were more likely to have completed reconstructive head and neck fellowships (94.6%) compared to ANZ surgeons (78.3%) and IS surgeons (46.2%). However, 91% of NA surgeons completed their fellowships in North America. In comparison, 71.4% of Indian surgeons completed their fellowship in India and 22% of ANZ surgeons completed their fellowship in Australia/New Zealand.

Timing of flap raising

80.5% of respondents in the survey indicated they predominantly perform synchronous flap raising to repair pharyngolaryngectomy defects with 15% performing an even combination of synchronous and metachronous reconstruction (Table-3). Alternatively known as two-surgeon or post-ablation flap raising, this process improves efficiency thereby reducing operative duration, reducing incidence of ‘night surgery,’ and reducing duration of anaesthesia which subsequently results in reduced complication rates and length of hospitalisation46-49. The rates of synchronous flap raising in this survey replicate the results of Kovatch et al. whose study found 98.5% of participating North American institutions performed synchronous reconstruction at least some of the time when performing microvascular free tissue transfer 23.

Use of preoperative vascular imaging  
The prevalence of vascular imaging, such as computed tomography angiography (CTA), in pharyngolaryngectomy defect reconstruction has not been previously described. This survey reveals that only 8.1% of surgeons routinely perform vascular imaging before functional free flap reconstruction (FFR), with no statistically significant variation between regions of surgical practice (Table 3). This finding contradicts evidence demonstrating that CTA to map perforating vessels reduces operative time, flap loss, and donor site morbidity50-52. Despite the well-described benefit of preoperative vascular imaging, this finding suggests that practicing surgeons may not personally perceive the additional investigation's benefits as justifying the potential improvements in patient outcomes53,54.

This study is the first to explore variations in surgical practice and decisions for complex head and neck reconstruction across three differing continents. Strengths of this survey include the large sample size in this subspecialty filed and reassuring completion rate (79.4%), thereby limiting non-response bias55,56. The survey was also designed to reduce acquiescence bias (tendency to agree with positive statement) with quantitative data preferred to reduce the subjectivity that often confounds survey studies26,27,57. Although this survey describes regional variance in surgical technique, it does not reflect variation in surgical outcomes between nations. The survey was also disseminated through surgical colleges or via leaders of large reconstructive departments to disseminate the survey through snowball sampling. These methods of data collection are limited by possible selection bias. Given the rarity and subspeciality of this procedure and the surgeons who perform this work, this was the only means of collecting data whilst ensuring a high completion rate58. Further research on pharyngolaryngectomy reconstruction, should consider variation in global practices which impact surgical decisions.

# *Acknowledgement*

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# *Data sharing statement*

Deidentified data may be requested for further academic use by liaison with the corresponding author.

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