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Practice Patterns in Parathyroid Surgery: A Survey of Asia-Pacific Parathyroid Surgeons

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Abstract

Background Practice variations exist amongst parathyroid surgeons depending on their expertise and resources. Our study aims to elucidate the choice of surgical techniques and adjuncts used in parathyroid surgery by surgeons in the Asia-Pacific region.

Methods A 25-question online survey was sent to members of five endocrine surgery associations. Questions covered training background, practice environment and preferred techniques in parathyroid surgery. Respondents were divided into three regions: Australia/New Zealand, South/South East Asia and East Asia, and responses were analysed according to region, specialty, case volume and years in practice.

Results One hundred ninety-six surgeons returned the questionnaire. Most surgeons (98%) routinely perform pre-operative imaging, with 75% preferring dual imaging with ^{99m}Tcsestamibi and ultrasound. Ten per cent of surgeons use parathyroid 4DCT as first-line imaging, more commonly in East Asia ($p = 0.038$). Minimally invasive parathyroidectomy is the favoured technique of choice (97%). Most surgeons reporting robotic or endoscopic approaches are from East Asia. Rapid intraoperative parathyroid hormone is accessible to just under half of the surgeons but less available in Australian/New Zealand ($p < 0.001$). The use of intraoperative neuromonitoring is not commonly used, even less so amongst Asian surgeons ($p = 0.048$) and surgeons with low case load ($p = 0.013$).

Conclusion Dual localisation techniques are the preferred choice of investigations in preparation for parathyroid surgery, with minimally invasive surgery without neuromonitoring the preferred approach. Use of adjuncts is sporadic and limited to certain centres.

Introduction

The first successful parathyroidectomy was performed in 1925. Bilateral neck exploration (BNE) remained the standard treatment for primary hyperparathyroidism

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(pHPT) for many years [1]. Improvements in parathyroid imaging have created disparities in practice between experienced surgeons, and image-guided minimally invasive parathyroidectomy (MIP) has gained traction. With concordant imaging, MIP cure rates rival conventional BNE with fewer complications, reduced hospitalisation and improved aesthetic results [2]. Newer intraoperative adjuncts such as intraoperative neuromonitoring (IoNM) and rapid intraoperative parathyroid hormone (IoPTH) assay have become available [3].

This study aims to assess variations in practice regarding localisation studies and surgical techniques in parathyroidectomy amongst surgeons in the Asia-Pacific region. We ascertain similarities and differences in practice based on surgeon experience and geographical region. Results will enable surgeons to reflect upon their own practices relative to the regional landscape. This is the first study in the literature looking at surgeons' preferences in investigation and management of parathyroid disease.

Materials and methods

Participants

After gaining ethics approval, a 25-question online survey was designed and sent via email link to members of the Australia and New Zealand Endocrine Surgeons (ANZES), Asian Association of Endocrine Surgeons (AsAES), Japanese Association of Endocrine Surgeons (JAES), Korean Association of Thyroid and Endocrine Surgeons (KATES) and Indian Association of Endocrine Surgeons (IAES). Participation was voluntary, and respondents could remain anonymous.

Questionnaire

An electronic Google Forms survey was used (Appendix in ESM). Responses were collected from March 2017 to March 2018. The questionnaire contained four sections: surgeon demographics, preoperative imaging, surgical technique and intraoperative adjuncts. Respondents were offered specific choices for each question or asked to express their agreement through a Likert scale. Each section had space for free text comments. Minimally invasive surgery was defined as focussed, image-guided exploration of the parathyroid glands.

Statistical analysis

The country of practice was grouped into three regions: Australia/New Zealand, East Asia and South/South East Asia. Duplicate records based on surgeon name and

incomplete responses were excluded from analysis. Stata 15 (STATA Corp, College station, TX, USA) was used for statistical analysis. Descriptive statistics were used to analyse the current trends in parathyroid imaging and surgery. Fisher's exact and Chi-square tests were used to determine associations between clinician responses and their experience and demographic factors. $p < 0.05$ was considered statistically significant.

Results

Of approximately 750 surveys emailed, 196 unique surveys were completed, for an estimated response rate of 26%. Distribution of responses was as follows: 63 (32%) from Australia/New Zealand, 97 (50%) from East Asia and 36 (18%) from South/South East Asia (Fig. 1). Language barriers in some countries may have impacted the response rate.

Most respondents from all three regions were experienced academic endocrine surgeons. Sixty-eight per cent had over 10 years' specialist experience, 75% worked either at University or teaching hospitals and 54% had endocrine surgery fellowship training (Table 1). Most respondents (71%) performed fewer than 20 parathyroidectomies annually.

Inter-regional variation exists. East Asian respondents were in practice the longest, as opposed to Australia/New Zealand, with 19% in their first 5 years of specialist practice ($p = 0.008$). Eleven per cent of respondents from Australia/New Zealand had an otolaryngology background. Most respondents work in units with two to seven parathyroid surgeons [$n = 154$ (79%)]. However, it is more common for East and South/South East Asian surgeons to be the only ones at their institution and only East Asian
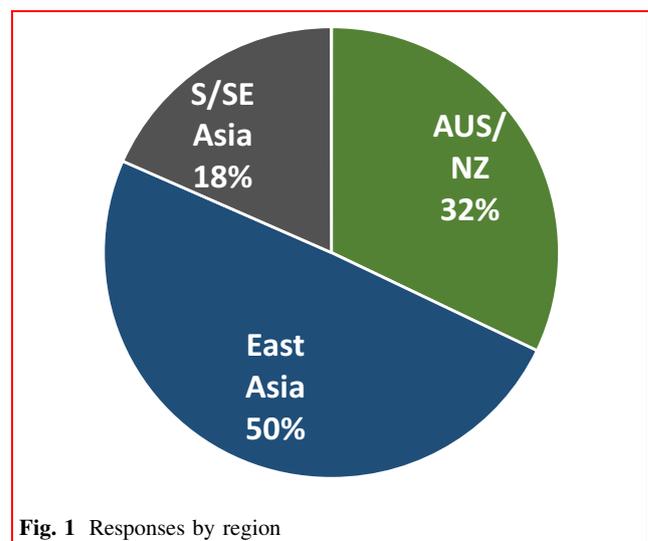

Fig. 1 Responses by region

Table 1 Demographic information of respondents by region

Total	Aus/NZ (%) $n = 63$	East Asia (%) $n = 97$	S/SE Asia (%) $n = 36$	Total (%) $n = 196$
Specialist experience				$p = 0.008$
<5 years	12 (19)	8 (8)	1 (3)	21 (11)
5–10 years	13 (21)	15 (16)	13 (36)	41 (21)
>10 years	38 (60)	74 (76)	22 (61)	134 (68)
Setting				$p = 0.217$
University/teaching hospital	48 (76)	66 (68)	1 (3)	147 (75)
Metropolitan hospital	7 (11)	11 (11)	33 (92)	19 (10)
Regional or rural hospital	7 (11)	17 (18)	2 (6)	26 (13)
Other	1 (2)	3 (3)	0	4 (2)
Number of parathyroid surgeons in institution				$p < 0.001$
I am the only one	2 (3)	23 (24)	9 (25)	34 (17)
2–4	44 (70)	49 (51)	22 (61)	115 (59)
5–7	17 (27)	17 (17)	5 (14)	39 (20)
>7	0	8 (8)	0	8 (4)
Individual's case load/year				$p < 0.001$
<20	27 (43)	85 (88)	28 (78)	140 (71)
21–50	24 (38)	12 (12)	5 (14)	41 (21)
>50	12 (19)	0	3 (8)	15 (8)
Institution's case load/year				$p < 0.001$
<20	8 (13)	60 (62)	15 (42)	83 (42)
21–50	19 (30)	26 (27)	10 (28)	55 (28)
51–100	21 (33)	10 (10)	9 (25)	40 (20)
>100	15 (24)	1 (1)	2 (5)	18 (9)

Aus/NZ Australia/New Zealand, *S/SE Asia* South/South East Asia

institutions have units with >7 parathyroid surgeons ($p < 0.001$). In comparison with their Asian counterparts, there is a higher per surgeon annual case load in Australia/New Zealand at both an institutional and individual level ($p < 0.001$).

Preoperative localisation and imaging

Most surgeons routinely perform preoperative imaging [$n = 193$ (98%)], with [99m]TcSestamibi and ultrasound the first-line modalities of choice [$n = 147$ (75%)] (Table 2). The remaining responses were ultrasound alone (17%), 4DCT (10%) or sestamibi alone (7%). Australia/New Zealand surgeons do not use 4DCT as first-line modality (3%) as often as their Asian colleagues (13%, $p = 0.038$). Thirteen respondents also report utilising MRI neck or CT for initial imaging. Over half (56%) perform their own ultrasound, and a similar proportion use radiology for ultrasound, indicating some surgeons use both. Less experienced surgeons are more likely to have radiology perform an ultrasound (70%, $p = 0.034$). Most sestamibi scans are performed with SPECT CT [$n = 103$, (70%)].

For negative or equivocal first-line imaging, there is considerable variation in the use of second-line imaging modalities (Table 3), with 37% of surgeons ordering 4DCT, 29% proceeding to the operating room with no further imaging and 27% repeating the sestamibi. Other imaging modalities used include repeat ultrasound and MRI. 4DCT for second-line imaging is more likely to be employed by Australia/New Zealand surgeons (63%, $p < 0.001$), surgeons with less than 10 years specialist experience (50%, $p = 0.006$) and those with high case load (48%, $p = 0.027$). In contrast, Asian surgeons prefer sestamibi or ultrasound ($p < 0.001$ and $p = 0.004$). Sestamibi is more commonly used by surgeons with a smaller case load ($p = 0.008$). Selective venous sampling prior to initial surgery is performed by a small minority of surgeons from Asian regions, and none from Australia/New Zealand ($p = 0.027$).

Surgical technique

For parathyroidectomy in pHPT, MIP is the predominant approach [$n = 189$ (97%)]. Ninety-six per cent use general

Table 2 Preoperative imaging preferences for first-time parathyroidectomy for pHPT

Initial imaging modalities	Aus/NZ n (%)	East Asia n (%)	S/SE Asia n (%)	Total n (%)	p
[99m]TcSestamibi only	7 (11)	5 (5)	2 (6)	14 (7)	
US only	3 (5)	23 (24)	8 (22)	34 (17)	
US and [99m]TcSestamibi	52 (83)	69 (71)	26 (72)	147 (75)	**0.011***
US by radiologist	40 (77)	24 (35)	20 (77)	63 (43)	**<0.001**
US by endocrine surgeon	23 (44)	51 (74)	8 (31)	82 (56)	**<0.001**
4DCT	2 (3)	13 (13)	3 (8)	18 (9)	0.089

Bold values indicate statistical significance ($p < 0.05$)

pHPT primary hyperparathyroidism, *Aus/NZ* Australia/New Zealand, *S/SE Asia* South/South East Asia, *US* ultrasound, *4DCT* four-dimensional computed tomography

*p Value is based on comparison US + Sestamibi versus US only and Sestamibi only

Table 3 Secondary imaging modalities (select all that apply)

	Aus/NZ n (%)	East Asia n (%)	S/SE Asia n (%)	Total n (%)	p
4DCT	40 (63)	20 (21)	11 (31)	71 (36)	**<0.001**
Nothing; proceed to theatre	20 (32)	27 (28)	10 (28)	57 (29)	0.853
[99m]TcSestamibi	5 (8)	35 (36)	10 (28)	50 (26)	**<0.001**
US	4 (6)	23 (24)	10 (27)	37 (19)	**0.004**
Selective venous sampling	0	12 (11)	5 (14)	17 (9)	**0.027**

Bold values indicate statistical significance ($p < 0.05$)

Aus/NZ Australia/New Zealand, *S/SE Asia* South/South East Asia, *4DCT* four-dimensional computed tomography, *US* ultrasound

anaesthetic, with only 4% preferring local or regional anaesthetic. Routine BNE is performed by five surgeons and endoscopic/video-assisted parathyroidectomy by nine surgeons, all of whom were surgeons with over 10 years specialist experience ($p = 0.028$). Otherwise, surgical technique did not vary between regions nor individual case load.

Two surgeons practise robotic parathyroidectomy. The main reasons cited for non-usage included lack of benefit, high cost, increased operative time, device unavailability and lack of required skill set. Despite regions reporting similar reasons, Australia/New Zealand surgeons (27%) are less likely to offer robotic parathyroidectomy if the costs were equivalent to conventional open surgery compared to East (42%) and South/South East (47%) Asian surgeons ($p = 0.031$).

Intraoperative adjuncts

Substantial divergence exists regarding intraoperative adjuncts (Table 4). Nearly half of all surgeons routinely use frozen section to confirm parathyroid tissue, similar across all regions. Amongst surgeons who routinely use intraoperative adjuncts, 50% of the South/South East Asian

surgeons rely on intraoperative ultrasound, in comparison with their Australian/New Zealand (17%) and East Asian (15%) colleagues ($p = 0.023$). Other adjuncts used include intraoperative methylene blue injection (6%) and gamma-probe (3%). Forty-five per cent of surgeons rely on visual identification, rather than technological adjuncts, to identify parathyroid tissue. One respondent uses 5-aminolevulinic acid for fluorescence identification. Use of adjuncts did not vary between surgeons experience and case load.

Rapid intraoperative parathyroid hormone assay

Regional variation exists in the access to rapid intraoperative parathyroid hormone assays (IoPTH). IoPTH is not available to half the respondents, especially Australian/New Zealand surgeons, $p < 0.001$ (Table 4). However, if given the opportunity to obtain access to IoPTH, Australian/New Zealand surgeons (27%) are less likely to use it routinely compared to East (51%) and South/South East Asian surgeons (42%, $p = 0.001$).

Table 4 Summary of current parathyroidectomy practices for pHPT by region

	Aus/NZ n (%)	East Asia n (%)	S/SE Asia n (%)	Total n (%)	p
Surgical approach					0.424
MIP	60 (96)	84 (87)	34 (97)	178 (92)	
Routine BNE	1 (2)	4 (4)	0	5 (3)	
Endoscopic	1 (2)	7 (7)	1 (3)	9 (4)	
Robotic	0	2 (2)	0	2 (1)	
Intraoperative adjuncts					0.097*
Not routinely used	28 (44)	39 (40)	22 (61)	89 (45)	
Routinely used:	35 (56)	58 (60)	14 (39)		
Frozen section[a]	32 (91)	49 (85)	10 (71)	91 (85)	0.188
US[a]	6 (17)	9 (16)	7 (50)	22 (21)	**0.023**
Blue injection[a]	2 (6)	8 (14)	1 (7)	11 (10)	0.547
Gamma-probe[a]	0	3 (5)	2 (14)	5 (5)	0.058
IoNM	14 (22)	11 (12)	4 (11)	29 (15)	0.177
Access to rapid IoPTH	12 (19)	48 (49)	18 (50)	78 (40)	**<0.001**

For intraoperative adjuncts if clinician responses to this question contained "Not Routinely" all other responses (e.g. US, frozen section, etc.) were not counted

Bold values indicate statistical significance ($p < 0.05$)

Aus/NZ Australia/New Zealand, *S/SE Asia* South/South East Asia, *MI* minimally invasive parathyroidectomy, *BNE* bilateral neck exploration, *US* ultrasound, *IoNM* intraoperative neuromonitoring, *IoPTH* intraoperative parathyroid hormone

[a] Proportion is calculated based on those who routinely used any of these procedures

*p Value is based on routinely versus not routinely comparison

Intraoperative neuromonitoring

Intraoperative neuromonitoring (IoNM) use differs greatly amongst surgeons; it is used routinely by only 16% of surgeons and selectively by 44%. Forty per cent of surgeons never use it, especially amongst East (43%) and South/South East Asian surgeons (56%) ($p = 0.048$) and surgeons performing individual case loads of less than 20 per year ($p = 0.013$). The main reasons cited for not using IoNM routinely are lack of benefit (54%) and cost (54%). There are no differences in usage based on surgeon type or years in practice.

Discussion

This study is the first to survey the practice patterns of surgeons performing parathyroidectomy for pHPT in the Asia-Pacific region. The intention was to document individual practices, which vary greatly as they are influenced by training, experience and practice environment. Moreover, variations may also exist due to differences in resourcing, cultural values and health-care systems.

Three quarters of Asia-Pacific surgeons prefer to use [99mTc]Sestamibi and ultrasound as first-choice imaging modality in pHPT, similar to the published literature recommendations and practice in North America [4–6]. The combination of [99m]TcSestamibi and ultrasound improves sensitivity and specificity compared to either modality alone and is the most cost-effective localisation method. Preoperative localisation and subsequently performed MIP reduce the rate of bilateral explorations [7, 8].

4DCT was introduced in 2006 and is gaining traction in second-line, and more recently, first-line imaging for pHPT [9]. In our survey, 47% of respondents elected to use 4DCT as their secondary imaging choice in case of negative or discordant first-line results, a practice commonly promoted in case series [10–14]. 4DCT in the hands of experienced imagers may be superior to [99m]TcSestamibi and ultrasound (sensitivity (89%) and PPV (94%)) [15, 16]. 4DCT is especially useful at detecting patients with multigland disease, ectopic glands and persistent or recurrent disease [13, 14]. Kunstman et al.'s algorithm suggests 4DCT can be used for negative or contradictory sestamibi and ultrasound results [4]. Our own data show reduced radiation exposure with 4DCT compared to previously reported [17, 18]. Our survey did not ask surgeons' reasons for their imaging choices, but use of CT amongst younger and high volume surgeons suggests that local availability and expertise likely plays a role.

With over 80% of pHPT arising from a single adenoma, the concept of performing routine BNE has fallen out of

favour in an era of improved preoperative localisation. The practice in the Asia-Pacific is similar to the evolution in North America [5], with MIP the preferred procedure for 92% of responding surgeons. Nevertheless, BNE remains the technique of choice for cases with failed localisation, multigland disease, familial hyperparathyroidism or concomitant thyroid pathology [19, 20]. Finally, in settings without access to quality imaging, MIP is not feasible, and this was the case for one respondent who routinely performs BNE in a rural institution [21].

The lack of consensus between surgeons to use frozen section for pHPT is reflective of the confounding evidence for its use. There is a lack of randomised trials that compare parathyroidectomy with or without frozen section. Furthermore, the use of IoPTH, when available, is a more specific indicator of adenoma removal [22–24] and thus obviating the need for frozen section.

An interesting finding is the high rates of MIP without routine use of IoPTH. Whilst non-use of IoPTH is contrary to the American Association of Endocrine Surgeons (AAES) guidelines and management techniques taught in North American fellowship programs [6, 25], it is consistent with the European Society of Endocrine Society (ESES) guidelines [26] and is similar to common practice outside academic centres in North America [27]. This finding may be attributable to a lack of availability of IoPTH, as revealed in our survey, where half of East Asian and South/South East Asian surgeons have access to IoPTH, whilst most Australian/New Zealand surgeons do not. However, even if IoPTH was available, only 41% of surveyed surgeons would routinely use this technique. This reflects the lack of strong evidence supporting its benefit [28–32], given 97–98% of well-selected patients will be cured after MIP without IoPTH [33–35]. Further, there is considerable variability in IoPTH criteria to predict intraoperative success [36, 37], an increase in mean operative time by 45 min [30], and increased cost.

Most endocrine surgeons use IoNM selectively as recommended by AAES and ESES guidelines [25, 26]. Nonetheless, a large proportion of surgeons do not use IoNM in parathyroidectomy, especially East Asian and South/South East Asian surgeons. In comparison, surgeons from the USA report higher routine use of IoNM in surveys [38, 39], with one demonstrating routine use in 85% of otolaryngologists [40]. Interestingly, a pertinent reason for IoNM use was for medicolegal reasons and their main reasons for non-usage did not include cost, which was a main concern for our respondents. One study demonstrated a 5–7% increase in costs for parathyroidectomy performed with IoNM [41].

Our finding of the highly varied use of IoNM in the Asia-Pacific reflects a poor evidence base for the benefit of IoNM in parathyroid surgery. Current studies tend to use combined cohorts of thyroid and parathyroid patients [42]. Evidence to date suggests no reduction in risk of permanent vocal cord palsy with the use of IoNM in thyroid surgery [43], and there is little evidence regarding its use in parathyroidectomy, where recurrent laryngeal nerve injury is even less common. Regardless, nerve visualisation remains the gold standard for nerve preservation in both types of surgeries [40]. This is the common attitude held by over half the respondents of our survey who quoted non-usage due to lack of benefit.

Endoscopic or video-assisted approaches have not been widely adopted despite being first described in the earliest uses of MIP [44–46]. It was only used as the primary approach by nine surgeons, who were predominately from East Asia. Its main value lies in avoiding a neck scar [22, 47, 48]. Whilst endoscopy may improve visualisation by providing light and magnification, introducing an endoscope into the neck may require more extensive dissection of structures than open surgery [4, 49, 50]. It is a more complex and time-consuming procedure that requires additional training [51]. Moreover, it is not appropriate for patients with previous neck surgery, large goitres or large parathyroid adenomas [21].

Similarly, robotic parathyroidectomy has not gained popularity. The disparity between Asian and Western surgeon preferences on using transaxillary robotic thyroidectomy has been attributed to greater value placed on neck cosmesis by Asian patients [10], who tend to have poorer cosmetic outcomes and higher risk of keloid scarring [52]. Moreover, this technique applied to the larger body habitus of Caucasian patients has a greater tendency towards more bleeding and risk of converting to open surgery [53].

There are inherent limitations of a survey-based study such as this. The response rate was low, albeit not uncommon for survey-based studies. Moreover, respondents were heavily weighted with experienced, academic surgeons who belong to their regional professional societies. These factors may skew the results towards perspectives of experienced and academic parathyroid surgeons. Nonetheless, the aim was not to determine exact percentages, but to describe the broad practice patterns of Asia-Pacific parathyroid surgeons. Furthermore, the demographics and geographic location of the responding surgeons were widespread. Finally, MIP was deliberately undefined in this survey as we feel this accurately reflects the blanket use of the term [54], which is acknowledged by current guidelines [25].

Conclusion

Practices amongst parathyroid surgeons differ in Asia-Pacific. The majority of surgeons utilise ^{99m}TcSestamibi and ultrasound as the first imaging modalities of choice and MIP as the procedure of choice when appropriate. IoNM use and remote access approaches are uncommon. The use of technological adjuncts varies widely amongst experienced surgeons. This study enables surgeons to be cognisant of the practice patterns of their colleagues abroad. The divergent findings suggest that developing consensus guidelines may be helpful in the Asia-Pacific to assist surgeons in providing safe and effective treatment to patients with pHPT.

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