

Simplified minimally invasive parathyroidectomy: a series of 100 cases and review of the literature

W Wong, FJ Foo, MI Lau, A Sarin, P Kiruparan

Department of General Surgery, Blackpool Victoria Hospital, Blackpool, UK

ABSTRACT

INTRODUCTION Conventional practice of parathyroidectomy has been collar incision with bilateral neck exploration and a four-gland evaluation. Our local practice involves simplified parathyroidectomy via mini-incision without routine use of intraoperative adjuncts. The aim of this study is to demonstrate that a good success rate can be achieved, which will hopefully encourage more to undertake minimally invasive parathyroid surgery.

MATERIALS AND METHODS A prospective case series of the first 100 patients undergoing minimally invasive parathyroidectomy (MIP) by a single surgeon at a single institution were included. Preoperatively, patients underwent ultrasonography (US) and/or a sestamibi (MIBI) scan for localisation. Parathyroidectomy was performed following an algorithm of intraoperative decisions. Serum calcium and/or parathyroid hormone levels were checked at follow-up. Postoperative normocalcaemia was considered success independent of serum parathyroid hormone levels

RESULTS The patients had a median age of 63 years. Of the 100 patients, 83 were female and 17 male. Seven patients had a conversion to bilateral exploration. The mean operative time for unilateral and bilateral exploration was 42.38 minutes and 76.43 minutes respectively. Separately, a MIBI scan and US lateralised the side of the lesion in 82.8% and 79.5% of cases respectively. When US and the MIBI scan agreed, the predictive accuracy of the side of the lesion was 87.5%. The majority of patients (96%) had a successful return to normocalcaemia. No complications were encountered.

CONCLUSIONS Excellent results are achievable with simplified MIP even without intraoperative adjuncts. Preoperative localisation is helpful in determining the side of incision. Our technique demonstrates a key principle of surgery: to keep things simple.

KEYWORDS

Parathyroidectomy – Hyperparathyroidism – Methylene blue – MIBI

Accepted 22 December 2010

CORRESPONDENCE TO

P Kiruparan, Consultant Surgeon, Department of General Surgery, Blackpool Victoria Hospital, Whinney Heys Road, Blackpool FY3 8NR, UK
T: +44 (0)1253 306 879; F: +44 (0)1253 306 818; E: mr.kiri@bfwhospitals.nhs.uk

Primary hyperparathyroidism (PHPT) is defined as symptomatic hypercalcaemia due to excessive parathyroid hormone (PTH) secretion in the absence of secondary or tertiary causes. Surgical management involves parathyroidectomy, which has shown to improve health-related quality of life.¹ Conventional surgical practice has been collar incision with bilateral neck exploration and a four-gland evaluation approach.

From the early 21st century, minimally invasive techniques of unilateral exploration and evaluation limited to the site of suspected lesion, as directed by preoperative localisation, were developed.² These include video-assisted parathyroidectomy, endoscopic parathyroidectomy and mini-incision parathyroidectomy.

Minimally invasive parathyroidectomy (MIP) showed a lower complication rate, with a reduced hospital stay and cost compared with the conventional approach.³ However, a national survey in the UK and Ireland noted that only 3% of consultant members of the British Association of Endocrine Surgeons were using the lateral incision approach, with the majority preferring the collar incision.⁴

Some centres use intraoperative parathyroid hormone (IOPTH) measurements as routine⁵ although the role of the IOPTH in parathyroidectomy at this point is questionable.⁶ Frozen sections are also used occasionally in parathyroid surgery to identify parathyroid tissue and differentiate it from non-parathyroid tissue with good accuracy.⁷

Our local practice utilises simplified parathyroidectomy. This involves a mini-incision without the routine use of IOPTH measurements and frozen sections. This study aims to demonstrate that a good success rate can be achieved without the use of any intraoperative adjuncts. This simplified technique will hopefully encourage more to undertake minimally invasive parathyroid surgery.

Materials and Methods

The first 100 patients who underwent MIP for PHPT from January 2008 done at a single institution by a single surgeon were recruited prospectively for this study. Preoperatively, patients underwent ultrasonography (US) and/or a ^{99m}Tc-labelled sestamibi (MIBI) scan for localisation. The risks were

Table 1 Results of similar studies of parathyroidectomies via the focused lateral approach

Author	Sample size (n)	Number of patients undergoing MIP	Conversion rate	Complication rate	Success rate
Udelsman <i>et al</i> , 2000 ²⁷	138	100		2%	100%
Sprouse <i>et al</i> , 2001 ³¹	50	47	4%	0%	94%
Bergenfelz <i>et al</i> , 2002 ¹⁶	91	47	38%	4%	96%
Udelsman <i>et al</i> , 2002 ²	656	255	11%	1%	98%
Fuchs <i>et al</i> , 2005 ³²	49	49	10%	5%	90%
Cohen <i>et al</i> , 2005 ³³	139	139		1%	99%
Cardenas <i>et al</i> , 2007 ³⁴	50	50	4%	2%	98%
Mihai <i>et al</i> , 2007 ³⁵	298	150	3%	3%	97%
Pang <i>et al</i> , 2007 ²⁶	1101	500		1%	97%
Haciyani <i>et al</i> , 2009 ³⁶	47	30		0%	97%
Present study	100	100	7%	0%	96%

explained, including the risk of conversion to collar incision and the risk of failure, and patients were consented.

A dose of 7.5mg/kg methylene blue was diluted in 500ml of 5% dextrose and infused one hour before surgery. A variety of anaesthetic techniques can be used including local anaesthesia, regional block and general anaesthesia, all of which we have utilised successfully. A focused lateral approach through a 2cm transverse skin crease mini-incision was sited directly over the parathyroid gland on the side indicated by preoperative imaging. The sternomastoid was mobilised laterally and strap muscles medially, revealing the lateral border of the thyroid gland. The adenoma was found on the posterior surface of the thyroid and identified by blue dye uptake. Resection was done without breach of the parathyroid capsule and avoiding injury to the recurrent laryngeal nerve.

In the absence of uptake and with an unidentifiable adenoma, the remaining ipsilateral parathyroid gland was explored via the same mini-incision. Further failure to identify an adenoma prompted a conversion to collar incision for conventional full exploration. In the event of uncertainty or identification of a suspicious lesion, a frozen section or IOPTH measurement was utilised. The algorithm of intraoperative decisions is shown in Figure 1.

No intraoperative adjuncts such as a gamma probe, IOPTH measurements or frozen sections were used routinely. Patients were discharged within 24 hours of surgery. Calcium and PTH levels were checked prior to discharge and patients were followed up in the outpatient clinic, where serum calcium and/or PTH levels were checked to determine success. Postoperative normocalcaemia (adjusted calcium 2.12–2.65mmol per litre) was considered success independent of serum PTH levels.

Results

The patients had a median age of 63 years (range: 26–85 years). Of the 100 patients, 85 were female and 17 male.

A total of 93 patients underwent MIP. Seven patients had a conversion from MIP to bilateral exploration. The mean operative time for unilateral exploration was 42.38 (standard deviation [SD]: 12.31) minutes and the mean operative time for bilateral exploration was 76.43 (SD: 16.51) minutes.

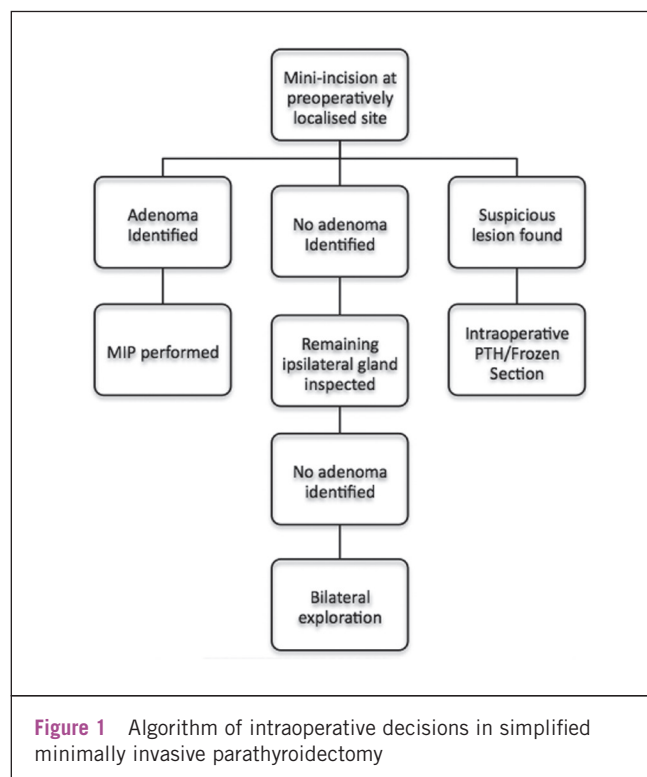
When used alone, the MIBI scan was able accurately to lateralise the side of the lesion in 82.8% of cases. US was able accurately to lateralise the side of the lesion in 79.5%. However, when both US and the MIBI scan agreed, the predictive accuracy of the side of the lesion was 87.5%.

The majority (96%) of patients had a successful return to normocalcaemia. No intraoperative or postoperative complications were encountered. Four patients had persistent hypercalcaemia postoperatively. Of these, two patients had a missed adenoma on the contralateral side. Subsequent re-imaging and MIP cured one patient and the other has been put on the waiting list for MIP. A further two patients were lost to follow-up.

Discussion

Management of patients with PHPT depends very much on patient presentation. Although most patients with PHPT may present with mild symptoms, 25–35% go on to develop complications, eg renal calculi and osteoporosis.^{8–10} Studies have shown that surgery reduces the incidence of PHPT-related complications such as fractures, gastric ulcers¹¹ and cardiovascular mortality.¹² Clinicians therefore have a low threshold in referring patients for parathyroidectomy as a cure for PHPT. This has led to a dramatic rise in parathyroidectomies performed worldwide from 1,727 in the year 1980 to 6,977 in the year 2000.¹⁵

Since the first parathyroidectomy in 1925 by Felix Mandl, surgeons have developed less invasive approaches to this operation.¹⁴ Numerous studies have been carried out to determine the best approach, be it conventional bilateral neck exploration or mini-incision parathyroidectomy. Ideally, a large multicentre randomised controlled trial with



adequate follow up would give us an answer. However, difficulties in both patient and investigator blinding, clashing personal interests, varying surgeon expertise and learning curves have impeded this. This has not deterred individuals from comparing different techniques retrospectively, often by accumulation of non-randomised data.¹⁵

Although a survey of members of the International Association of Endocrine Surgeons in 2002 illustrated a general adaptation towards the focused mini-incision approach worldwide,¹⁵ uptake of this technique in the UK and Ireland is poor, with 97% of surgeons still adopting the bilateral neck exploratory approach.⁴

MIP has been shown to be the superior approach. There is a two-fold higher complication rate (3.0%) in the conventional approach compared with that in MIP (1.2%) although the risk of ipsilateral recurrent laryngeal nerve injury is similar (0.7% and 0.8% respectively).²

In a prospective randomised controlled trial, unilateral neck exploration yielded the same cure rate and histology as the bilateral approach. However, patients in the bilateral group had a higher incidence of early symptomatic hypocalcaemia, consumed more oral calcium and had lower serum calcium postoperatively compared with the unilateral group.¹⁶ Apart from reduced risk of hypocalcaemia, MIP offers a 50% reduction in operating time, a reduced length of hospital stay and a 50% reduction in cost with a mean cost saving of \$2,693 per patient.²

These factors have led to a gradual paradigm shift towards minimal access parathyroid surgery.

In our study, the mean operative time for unilateral neck exploration was only 42.38 (SD: 12.51) minutes compared with 76.45 (SD: 16.51) minutes for the bilateral approach.

All patients were discharged the following day. No intraoperative or postoperative complications were encountered. None of the patients developed haematomas or laryngeal nerve palsy. We have shown that our simplified technique of MIP can be carried out safely with dramatically less operative time.

Preoperative localisation is paramount, particularly in MIP, to determine the site of incision. A MIBI scan is the imaging of choice with a positive predictive value of 86%.¹⁷ The scan results are dependent on the size of the lesion and calcium levels.¹⁸

US is a cheap, convenient and non-invasive modality that has a sensitivity of 73% and a positive predictive value of 100% in single parathyroid adenomas.¹⁹ In competent hands, US is capable of providing precise anatomical detail that corresponds closely to surgical findings 92% of the time.²⁰ Sensitivity and accuracy of this mode of imaging, however, is operator-dependent and ectopic adenomas may be missed.²¹

When these two imaging modalities are combined, solitary adenoma localisation is increased by at least 10–20%. The positive predictive value for combined MIBI scans and US remains high (97%) even in patients with concomitant multinodular thyroid disease when compared with a MIBI scan alone (94%) and US alone (88%).²²

In order to determine the superior mode of imaging, we analysed the concordance of imaging against the operative findings. When used separately, MIBI scans and US were able to lateralise the side of the lesion accurately in 82.8% and 79.5% of cases respectively but when US and MIBI scans agreed, the predictive accuracy of the side of the lesion was 87.5%.

In minimal access parathyroidectomy with a unilateral approach, visualisation of all four glands is impractical. It is therefore not surprising that a number of centres routinely use intraoperative adjuncts with the aim of reducing operative failure rates and the risk of subsequent re-exploration. However, data from studies to support the use of these adjuncts have been unable to show significant improvement in success rates to justify the additional cost incurred. Indeed, the cost-effectiveness of these intraoperative adjuncts are questionable.

IOPTH measurements are reliable only in half of patients with multiple abnormal parathyroid glands. IOPTH levels may fall to a reassuring degree even in patients with remaining abnormal glands only for patients to present again later with hypercalcaemia.^{25,24} The commonly accepted reduction in IOPTH levels (>50%) may lead to missed adenomas or hyperplastic disease.²⁵ Analysis of postoperative PTH data concluded that the use of IOPTH measurements would only raise the cure rate by 1% at best.²⁶

IOPTH measurement usage also has limitations in patients on lithium or under propofol sedation, which has to be stopped 5–10 minutes prior to PTH sampling.²⁷ Although some centres believe IOPTH measurements are essential for a high success rate,^{28–50} we have managed to obtain a 96% success rate without the routine use of IOPTH measurements or frozen sections. This is comparable with results from other similar studies (Table 1). Taking into ac-

count that double parathyroid adenomas occur in 2–15% of PHPT cases,⁵⁷ we obtained an acceptable missed adenoma rate of 2–4%, including the possibility that the two patients that were lost to follow-up may possibly have had a missed adenoma.

In cases of indecision or a suspicious lesion, frozen sections and/or IOPH measurements may assist judgement but the use of these investigations as routine is unnecessary.⁵⁸

Patients undergoing MIP are well informed of the risk of conversion to bilateral neck exploration. However, this should not be regarded as a complication, rather as a risk that further exploration has to be undertaken should an adenoma not be found. In a study on 656 patients, using the focused lateral approach, a conversion rate of 11% was reported.²

Out of 100 cases we had a conversion rate of 7%, showing that most cases are amenable to minimally invasive surgery.

Conclusions

Excellent results are achievable with simplified MIP even without intraoperative adjuncts. Preoperative localisation is helpful in determining the side of incision. Our technique demonstrates a key principle of surgery: to keep things simple.

References

- Sheldon DG, Lee FT, Neil NJ, Ryan JA Jr. Surgical treatment of hyperparathyroidism improves health-related quality of life. *Arch Surg* 2002; **137**: 1,022–1,026.
- Udelsman R. Six hundred fifty-six consecutive explorations for primary hyperparathyroidism. *Ann Surg* 2002; **235**: 665–670.
- Howe JR. Minimally invasive parathyroid surgery. *Surg Clin North Am* 2000; **80**: 1,399–1,426.
- Ozbas S, Pain S, Tang T, Wishart GC. Surgical management of primary hyperparathyroidism – results of a national survey. *Ann R Coll Surg Engl* 2003; **85**: 236–241.
- Irvin GL 3rd. Presidential address: chasin' hormones. *Surgery* 1999; **126**: 993–997.
- Clark OH. How should patients with primary hyperparathyroidism be treated? *J Clin Endocrinol Metab* 2003; **88**: 3,011–3,014.
- Westra WH, Pritchett DD, Udelsman R. Intraoperative confirmation of parathyroid tissue during parathyroid exploration: a retrospective evaluation of the frozen section. *Am J Surg Pathol* 1998; **22**: 538–544.
- Scholz DA, Purnell DC. Asymptomatic primary hyperparathyroidism. 10-year prospective study. *Mayo Clin Proc* 1981; **56**: 473–478.
- Mitlack BH, Daly M, Potts JT Jr *et al*. Asymptomatic primary hyperparathyroidism. *J Bone Miner Res* 1991; **6 Suppl 2**: S103–S110.
- Silverberg SJ, Shane E, Jacobs TP *et al*. A 10-year prospective study of primary hyperparathyroidism with or without parathyroid surgery. *N Engl J Med* 1999; **341**: 1,249–1,255.
- Vestergaard P, Mosekilde L. Cohort study on effects of parathyroid surgery on multiple outcomes in primary hyperparathyroidism. *BMJ* 2003; **327**: 530–534.
- Lundgren E, Lind L, Palmér M *et al*. Increased cardiovascular mortality and normalized serum calcium in patients with mild hypercalcemia followed up for 25 years. *Surgery* 2001; **130**: 978–985.
- Sackett WR, Barraclough B, Reeve TS, Delbridge LW. Worldwide trends in the surgical treatment of primary hyperparathyroidism in the era of minimally invasive parathyroidectomy. *Arch Surg* 2002; **137**: 1,055–1,059.
- Mandl F. Therapeutic attempt for osteitis fibrosa generalisata via the excision of parathyroid tumours. *Wien Klin Wochenschr* 1925; **38**: 1,343–1,344.
- McCulloch P, Taylor I, Sasako M *et al*. Randomised trials in surgery: problems and possible solutions. *BMJ* 2002; **324**: 1,448–1,451.
- Bergenfels A, Lindblom P, Tibblin S, Westerdaal J. Unilateral versus bilateral neck exploration for primary hyperparathyroidism: a prospective randomized controlled trial. *Ann Surg* 2002; **236**: 543–551.
- Civelek AC, Ozalp E, Donovan P, Udelsman R. Prospective evaluation of delayed technetium-99m sestamibi SPECT scintigraphy for preoperative localization of primary hyperparathyroidism. *Surgery* 2002; **131**: 149–157.
- Swanson TW, Chan SK, Jones SJ *et al*. Determinants of Tc-99m sestamibi SPECT scan sensitivity in primary hyperparathyroidism. *Am J Surg* 2010; **199**: 614–620.
- Bhansali A, Masoodi SR, Bhadada S *et al*. Ultrasonography in detection of single and multiple abnormal parathyroid glands in primary hyperparathyroidism: comparison with radionuclide scintigraphy and surgery. *Clin Endocrinol (Oxf)* 2006; **65**: 340–345.
- Yeh MW, Barraclough BM, Sidhu SB *et al*. Two hundred consecutive parathyroid ultrasound studies by a single clinician: the impact of experience. *Endocr Pract* 2006; **12**: 257–263.
- Senchenkov A, Staren ED. Ultrasound in head and neck surgery: thyroid, parathyroid, and cervical lymph nodes. *Surg Clin North Am* 2004; **84**: 973–1,000.
- Krausz Y, Lebensart PD, Klein M *et al*. Preoperative localization of parathyroid adenoma in patients with concomitant thyroid nodular disease. *World J Surg* 2000; **24**: 1,573–1,578.
- Gauger PG, Agarwal G, England BG *et al*. Intraoperative parathyroid hormone monitoring fails to detect double parathyroid adenomas: A 2-institution experience. *Surgery* 2001; **130**: 1,005–1,010.
- Perrier ND, Ituarte PH, Morita E *et al*. Parathyroid surgery: separating promise from reality. *J Clin Endocrinol Metab* 2002; **87**: 1,024–1,029.
- Karakousis GC, Han D, Kelz RR *et al*. Interpretation of intra-operative PTH changes in patients with multi-glandular primary hyperparathyroidism (pHPT). *Surgery* 2007; **142**: 845–850.
- Pang T, Stalberg P, Sidhu S *et al*. Minimally invasive parathyroidectomy using the lateral focused mini-incision technique without intraoperative parathyroid hormone monitoring. *Br J Surg* 2007; **94**: 315–319.
- Udelsman R, Donovan PI, Sokoll LJ. One hundred consecutive minimally invasive parathyroid explorations. *Ann Surg* 2000; **232**: 331–339.
- Chen H, Pruhs Z, Starling JR, Mack E. Intraoperative parathyroid hormone testing improves cure rates in patients undergoing minimally invasive parathyroidectomy. *Surgery* 2005; **138**: 583–587.
- Westerdaal J, Bergenfels A. Sestamibi scan-directed parathyroid surgery: potentially high failure rate without measurement of intraoperative parathyroid hormone. *World J Surg* 2004; **28**: 1,132–1,138.
- Barczynski M, Konturek A, Cichon S *et al*. Intraoperative parathyroid hormone assay improves outcomes of minimally invasive parathyroidectomy mainly in patients with a presumed solitary parathyroid adenoma and missing concordance of preoperative imaging. *Clin Endocrinol (Oxf)* 2007; **66**: 878–885.
- Sprouse LR 2nd, Roe SM, Kaufman HJ, Williams N. Minimally invasive parathyroidectomy without intraoperative localization. *Am Surg* 2001; **67**: 1,022–1,029.
- Fuchs SP, Smits AB, de Hooge P *et al*. Minimally-invasive parathyroidectomy: a good operative procedure for primary hyperparathyroidism even without the use of intraoperative parathyroid-hormone assessment or a gamma probe. *Ned Tijdschr Geneeskde* 2005; **149**: 1,463–1,467.
- Cohen MS, Finkelstein SE, Brunt LM *et al*. Outpatient minimally invasive parathyroidectomy using local/regional anesthesia: a safe and effective operative approach for selected patients. *Surgery* 2005; **138**: 681–687.
- Gil-Cárdenas A, Gamino R, Reza A *et al*. Is intraoperative parathyroid hormone assay mandatory for the success of targeted parathyroidectomy? *J Am Coll Surg* 2007; **204**: 286–290.
- Mihai R, Palazzo FF, Gleeson FV, Sadler GP. Minimally invasive parathyroidectomy without intraoperative parathyroid hormone monitoring in patients with primary hyperparathyroidism. *Br J Surg* 2007; **94**: 42–47.
- Haciyani M, Genc H, Damburaci N *et al*. Minimally invasive focused parathyroidectomy without using intraoperative parathyroid hormone monitoring or gamma probe. *J Postgrad Med* 2009; **55**: 242–246.
- Abboud B, Sleilaty G, Helou E *et al*. Existence and anatomic distribution of double parathyroid adenoma. *Laryngoscope* 2005; **115**: 1,128–1,131.
- Agarwal G, Barakate MS, Robinson B *et al*. Intraoperative quick parathyroid hormone versus same-day parathyroid hormone testing for minimally invasive parathyroidectomy: a cost-effectiveness study. *Surgery* 2001; **130**: 963–970.