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REVIEW ARTICLE

Use of minimally invasive parathyroidectomy techniques in sporadic primary hyperparathyroidism: systematic review

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Abstract

The past two decades have seen rapidly changing attitudes towards the surgical management of primary hyperparathyroidism. Advances in localisation techniques and confidence with endoscopy have led to the development of numerous minimally invasive parathyroidectomy approaches, including open minimal incision and endoscopic and video-assisted parathyroidectomy.

This paper systematically reviews the evidence for these methods to determine: (1) whether these new, minimally invasive techniques are comparable to conventional bilateral neck exploration methods in terms of success and complication rate; and (2) if they are comparable, which technique is likely to be best for cosmesis, patient safety and patient satisfaction.

A search of the Medline, Cochrane Reviews and Scopus databases was conducted, using a defined list of search parameters. Abstracts were compared against inclusion and exclusion criteria, before the full text was sought and analysed for data. The evidence from each study was then assessed, based on study quality, and a recommendation made based on the level of evidence available.

There is level 1b evidence that minimally invasive surgery is comparable to bilateral neck exploration in terms of efficacy and complication rates. This paper recommends that the treatment of choice for solitary adenoma (in most healthcare centres) should be open minimal incision parathyroidectomy, due to advantages in operative duration, learning curve and cost-effectiveness.

Key words: Primary Hyperparathyroidism; Parathyroidectomy, Video-Assisted; Surgical Procedures, Minimally Invasive; Systematic Review

Introduction

Treatment for sporadic primary hyperparathyroidism has evolved greatly over the past 10 to 20 years. The development of numerous minimally invasive parathyroidectomy techniques places a burden of choice on the surgeon. Additionally, the original standard practice of bilateral neck exploration is a tried and tested technique with an extremely high success rate, few complications and a high patient satisfaction rate; thus, is minimally invasive surgery really more beneficial?

This paper aims to answer this question by systematically reviewing literature comparing different operative techniques, in order: (1) to grade the level of evidence supporting minimal access surgery as being equally effective or better than bilateral neck exploration; and (2) to give a recommendation on which minimal access technique is best, and in which situation, based on the evidence.

Primary hyperparathyroidism

Sporadic primary hyperparathyroidism is the third commonest endocrine disorder.[1] It is normally due to a single adenoma, resulting in increased release of parathyroid hormone and secondary hypercalcaemia. Other causes include parathyroid hyperplasia and carcinoma. The incidence of sporadic primary hyperparathyroidism is increasing in the Tayside region of Scotland; in the year 2006, it was thought to be 672/100 000 (diagnosed by biochemical analysis), and affected females much more than males (with a sex ratio of almost 3:1).[2] The general incidence of the condition also increases with age, with the peak incidence found in women aged between 50 and 60 years.[1]

The aetiology of sporadic primary hyperparathyroidism is unknown, although irradiation has been implicated. Survivors of the Hiroshima atomic bomb had a fourfold increase in susceptibility, whilst irradiation for acne may increase the incidence two- to threefold.[1]

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The vast majority of sporadic primary hyperparathyroidism cases are detected in asymptomatic individuals via routine biochemistry screening in hospital, with 70–80 per cent of individuals having no symptoms of their condition.[3] Other cases have symptoms of hypercalcaemia and excess mineral resorption from the bones, with the most common presentation being nephrolithiasis. Other presentations include osteoporosis and related poor fracture healing, acute hypercalcaemic crisis, acute pancreatitis, and psychiatric symptoms (depression, dementia and confusion).[4]

The condition is diagnosed based on the corrected serum calcium level, which is normally elevated, and the serum parathyroid hormone, which by definition is raised.

The only cure is surgical excision of the causative adenoma(s) or of hypertrophic tissue (i.e. subtotal parathyroidectomy).

Although symptomatic hyperparathyroidism is a clear indication for surgery, controversy remains over the treatment of the more numerous asymptomatic patients with sporadic primary hyperparathyroidism. The Third International Workshop on Primary Hyperparathyroidism[5] concluded that, due to the risks of osteoporosis, nephrolithiasis, heart disease and unrecognised neuropsychiatric complications of asymptomatic sporadic primary hyperparathyroidism, surgery was indicated in the majority of cases with a clear biochemical diagnosis (although further randomised, controlled trials on the subject were required for confirmation).

Bilateral neck exploration

Traditionally, the surgical treatment of choice for sporadic primary hyperparathyroidism has been bilateral neck exploration. This involves initial bilateral, 1–2 cm, supraclavicular collar incisions which are often extended to 3–6 cm.[6] The surgeon explores via these entry routes, in order to visualise all parathyroid glands. Enlarged glands are identified macroscopically and removed. It is normal practice to also biopsy one or more apparently normal parathyroid glands, to exclude gland disease. Intra-operative parathyroid hormone monitoring can be performed to ensure all dysfunctional tissue has been removed. This technique remains the 'gold standard' for parathyroidectomy treatment.

Minimal access parathyroidectomy

Surgeons have subsequently questioned the necessity of performing a bilateral procedure in cases in which it is clearly possible to operate unilaterally. The emergence of increasingly more accurate localising techniques (e.g. sestamibi-technetium 99m scintigraphy (known as sestamibi scanning), four-dimensional computed tomography (CT) and ultrasonography) have facilitated more focused adenoma excision, minimising the cosmetic impact of surgery and the length of the operation.

Pre-operative localisation

Current practice indicates that pre-operative localisation of affected glands is required before proceeding with minimal access parathyroidectomy. Ultrasonography is an accurate imaging technique which is both cost-effective and non-invasive. It is used to show enlarged glands, and has a 70–80 per cent accuracy rate.[7]

It is more common to use ultrasonography in conjunction with sestamibi scanning. Single-photon emission computerized tomography (SPECT) scanning can also be added, to provide additional anatomical localisation of affected glands. The combination of the three modalities has an 80–90 per cent accuracy rate, although false positives can occur due to coexisting thyroid nodules or lymph nodes which may mimic parathyroid activity.[8]

Four-dimensional CT has a role in investigating multiglandular and persistent sporadic primary hyperparathyroidism. Its use in routine pre-operative localisation is under investigation.

Endoscopic and video-assisted parathyroidectomy

Endoscopic parathyroidectomy was first performed by Naitoh *et al.*,[9] and involved a midline 30° endoscope and CO_2 insufflation, allowing access to both ipsilateral glands. Since this initial operation was devised, a number of alternative routes have been used, including the axilla, anterior chest wall and lateral neck.[8] The technique has evolved to include projection of the endoscopic image onto a liquid crystal display monitor, hence the term 'video-assisted minimal access parathyroidectomy'.

The two major video-assisted parathyroidectomy techniques currently in use are the Henry technique and Miccoli technique.

The former was first described by J F Henry and colleagues. After single gland disease is identified by imaging, a lateral approach is used via a 10 mm incision located at the anterior edge of the sternocleidomastoid muscle, and a space is dissected between the ipsilateral thyroid lobe, the carotid artery and the internal jugular vein.[10] A 0° endoscope is introduced and low pressure CO_2 insufflation is used to expand an artificial space (which can lead to subcutaneous emphysema).

An alternative method of video-assisted minimal access parathyroidectomy has been developed by P Miccoli *et al.* In this technique, single gland disease is identified by sestamibi or ultrasound scanning.[11] A 2 cm, midline incision is made 3 cm superior to the sternal notch. From there, artificial space is opened up on the suspected side of the lesion, using retractors. Unlike the above two techniques, gas insufflation is not required, thereby avoiding the potential complication of subcutaneous emphysema.

The main benefits provided to the surgeon by video-assisted minimal access parathyroidectomy are (1) tactile control over the procedure and (2) magnified endoscopic vision.[8]

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Open minimal incision parathyroidectomy

Open minimal incision parathyroidectomy has become the most common method of solitary parathyroid adenoma resection used worldwide.[8] Numerous approaches have been described, but the technique normally involves a central or lateral 2–4 mm incision, with resection of only the tissue involved. Recent advances have enabled the development of radio-guided minimal access parathyroidectomy, whereby technetium 99m is administered two hours pre-operatively and a gamma-probe then used to locate the abnormal gland. This is normally combined with the injection of methylene blue dye, which is taken up by the adenoma and colours it blue, enabling easy visualisation.[8]

Materials and methods

The journal databases PubMed, Scopus and Cochrane Reviews were searched using the following key words: primary parathyroidism AND endoscopic parathyroidectomy OR video-assisted parathyroidectomy OR videoscopic parathyroidectomy OR minimal access parathyroidectomy, to be found in the paper title, abstract or key words. Unilateral exploration was not studied, as the authors felt this was not a proper minimally invasive technique.

After papers were retrieved, their abstracts were read and compared to set exclusion and inclusion criteria, as described in Table I. Accepted studies were also required to include at least one of the following outcomes: pre- and post-operative serum calcium and parathyroid hormone levels; scar length or cosmetic satisfaction; length of hospital stay; analgesic requirements; post-operative morbidity; and duration in surgery.

The retrieved papers with the highest levels of evidence for each of the three techniques are described below, in order to establish recommendations for these techniques.

Results

Papers comparing minimally invasive parathyroidectomy techniques mainly comprised 26 retrospective case series,[8,9,12–34] which showed the feasibility of all established minimally invasive parathyroidectomy techniques as satisfactory alternatives to bilateral neck exploration.

TABLE I
REVIEW EXCLUSION AND INCLUSION CRITERIA

Exclusion criteria	Inclusion criteria*
2° hyperparathyroidism	PTH conc
Tertiary hyperthyroidism	Serum calcium conc
Multinodular hyperthyroidism	Scar length
MEN type I or II	Cosmetic satisfaction
Paediatric cases	Hospital stay duration
Animal models	Analgesic requirements
Literature reviews	Post-operative morbidity
	Peri-operative duration

*One of the following. 2° = secondary; PTH = parathyroid hormone; conc = concentration; MEN = multiple endocrine neoplasia

In addition, we found seven randomised, controlled studies[11,13–40] and one control-matched study[10] which met the review inclusion criteria. These included: a study of central video-assisted minimal access parathyroidectomy versus bilateral neck exploration;[11] a study of central video-assisted minimal access parathyroidectomy versus endoscopic bilateral neck exploration (by the same research group as the previous paper);[39] a case–control study of lateral video-assisted minimal access parathyroidectomy versus bilateral neck exploration;[10] two comparisons of open minimal incision parathyroidectomy versus bilateral neck exploration;[36,40] two studies of open minimal incision parathyroidectomy versus central video-assisted minimal access parathyroidectomy;[37,38] and one study of mixed central and lateral video-assisted minimal access parathyroidectomy versus open minimal incision parathyroidectomy.[35]

Video-assisted minimally invasive parathyroidectomy

Central video-assisted minimal access parathyroidectomy, as described by Miccoli *et al.*, was compared with bilateral neck exploration in a 1999 Italian study.[11] This study assessed 38 patients with solitary adenoma disease confirmed on imaging, who underwent either bilateral neck exploration ($n = 18$) or video-assisted minimal access parathyroidectomy ($n = 20$). This study was small in scale, and was conducted early in the adoption period of video-assisted minimal access parathyroidectomy. Even so, findings suggested that video-assisted minimal access parathyroidectomy had significant advantages regarding operative time, post-operative pain score and cosmetic satisfaction (although the statistical significance of outcome differences was questionable).

Another study[39] compared video-assisted minimal access parathyroidectomy to a minimally invasive form of endoscopic bilateral neck exploration. Forty patients were included, 20 in each treatment group. There were no significant differences for any outcome, comparing the two techniques: operative times, success rates (100 per cent in both groups) and complication rates were similar. Furthermore, localisation techniques appeared to have a 100 per cent positive predictive value, with no conversions to open bilateral neck exploration being required in either group; however, the small sample size invalidates conclusions on this point.

Lateral video-assisted minimal access parathyroidectomy, as described by Henry *et al.*, was studied in a French case–control study.[10] Sixty-eight patients meeting criteria for solitary adenoma were operated upon using the lateral video-assisted minimal access parathyroidectomy technique; a retrospectively matched group of patients undergoing bilateral neck exploration was used as a control. The success rate

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was the same for both groups (100 per cent), with similar complication rates (1 per cent for video-assisted minimal access parathyroidectomy and 4 per cent for bilateral neck exploration). Cosmetic satisfaction and post-operative analgesia requirement were significantly better in video-assisted minimal access parathyroidectomy patients, with analgesia being required 0.48 times per patient in the video-assisted minimal access parathyroidectomy group compared with 1.66 times in the bilateral neck exploration group during the first two days. On verbal response scoring, 95 per cent of video-assisted minimal access parathyroidectomy patients considered cosmetic result to be 'excellent', compared with 67.2 per cent of bilateral neck exploration patients. Operative times and post-operative hospitalisation times did not differ significantly between the two groups, although this may reflect the surgeons' inexperience with the technique and the French healthcare system (there was a mean post-operative hospitalisation time of 3.7 days for both procedures), respectively.

Open minimal incision parathyroidectomy

A Swedish study by Bergenfelz and colleagues compared open minimal incision parathyroidectomy under local anaesthesia versus bilateral neck exploration under general anaesthesia.[36] Fifty patients were randomly allocated to undergo one of the two procedures (25 patients in each group), following pre-operative localisation of solitary gland disease. As with video-assisted minimal access parathyroidectomy, similar success rates were found for the two procedures, with only one patient (4 per cent) in the bilateral neck exploration group having a failed procedure, due to gland hyperplasia (which was subsequently cured on re-operation). Three patients (12 per cent) undergoing open minimal incision parathyroidectomy had to be converted to bilateral neck exploration due to failed localisation of the affected gland or poor tolerance of local anaesthesia. Operative time was significantly better in the open minimal incision parathyroidectomy group, with a median time of 41 minutes, including local anaesthesia, versus 63 minutes for bilateral neck exploration, not including general anaesthesia (induction of which took a median extra time of 96 minutes). In this study, there was no significant difference in patients requiring post-operative analgesia (seven open minimal incision parathyroidectomy patients versus 10 bilateral neck exploration patients) or in the number of complications (symptomatic hypocalcaemia occurred in 17 bilateral neck exploration patients and 15 open minimal incision parathyroidectomy patients, and there was a temporary recurrent laryngeal nerve palsy in one bilateral neck exploration patient). The issue with this study was the confusion over how much the results were influenced by the difference in technique, as opposed to the difference in anaesthesia.

A Lithuanian paper by Slepavicius *et al.* studied open minimal incision parathyroidectomy versus bilateral neck exploration, both conducted under general anaesthesia.[40] This double-blinded study involved 47 patients who underwent one of the two procedures (open minimal incision parathyroidectomy in 24 and bilateral neck exploration in 23) after positive localisation of disease. Again, operative time was significantly quicker in open minimal incision parathyroidectomy patients (mean of 36 minutes) than in bilateral neck exploration patients (64 minutes), although inclusion of time to extubation made the results quite similar (i.e. 82 and 84 minutes, respectively). This change was mainly due to the 30 minute wait for results of intra-operative parathyroid hormone assay. This study also found that the open minimal incision parathyroidectomy patients had a significantly reduced analgesia requirement (patients required half the pain relief) and a shorter scar length (1.9 versus 8.0 cm, respectively), compared with their bilateral neck exploration counterparts. Post-operative cosmetic satisfaction was better in open minimal incision parathyroidectomy patients after one month, although this difference became insignificant at four months. All patients in both groups were cured, and complication rates were similar: both groups had one case of transient recurrent laryngeal nerve palsy, and symptomatic hypocalcaemia was seen in two open minimal incision parathyroidectomy patients versus four bilateral neck exploration patients. Although otherwise a very well performed study, the low numbers of participants was, again, a weakness.

Open minimal incision versus video-assisted minimally invasive parathyroidectomy

Barczynski *et al.* have published two Polish papers comparing the Miccoli technique of video-assisted minimal access parathyroidectomy versus open minimal incision parathyroidectomy.

The first study[37] included 60 patients (divided 30:30 between the two procedures) and showed similar success rates, operative times and complication rates. However, video-assisted minimal access parathyroidectomy appeared the preferable method, based on better pain scores, lower analgesia requirements and shorter scar length (1.7 cm, versus 3.1 cm in open minimal incision parathyroidectomy patients). Similar to Slepavicius and colleagues' results, post-operative cosmetic satisfaction was better in the video-assisted minimal access parathyroidectomy patients at one month, but was not significantly different after six months.

The second study[38] repeated the first study but extended the sample population to include 168 patients (100 video-assisted minimal access parathyroidectomy cases and 68 open minimal incision parathyroidectomy cases). Again, this study showed low conversion rates to bilateral neck exploration, high success rates (only one video-assisted minimal access parathyroidectomy

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patient had a failed operation, due to an undetected ectopic gland). Mean operative times were similar, although quicker than in the previous study for both groups, possibly reflecting the learning curve required for both operations. As a side-note, although not an aim of surgery, the recurrent laryngeal nerve was identified in 88 per cent of video-assisted minimal access parathyroidectomy patients, compared with 66 per cent of open minimal incision parathyroidectomy patients. This is probably a result of the former procedure's better visualisation, due to the magnified endoscopic view, and represents another benefit of this type of surgery (although it has not been shown to decrease rates of recurrent laryngeal nerve paralysis significantly). Building on the conclusions of the first study, pain scores, analgesia requirement and scar length were again lower in video-assisted minimal access parathyroidectomy patients, and patient satisfaction was better for the first post-operative month only. Due to the high success rates, it would be wise to question whether open minimal incision parathyroidectomy in such patients could be performed with an even smaller incision.

The most recent randomised, controlled trial on this subject, published in 2010, again compared video-assisted minimal access parathyroidectomy versus open minimal incision parathyroidectomy. Hessman and colleagues[35] studied 143 patients from across Sweden and Denmark, 68 undergoing video-assisted minimal access parathyroidectomy and 75 undergoing open minimal incision parathyroidectomy. The video-assisted minimal access parathyroidectomy patients underwent either the Miccoli ($n = 26$) or the Henry ($n = 42$) technique. Having evaluated the evidence from the Barczynski papers, open minimal incision parathyroidectomy was performed via a shorter incision. The only detectable difference in this study was a shorter operative duration in open minimal incision parathyroidectomy patients, with a mean duration of 60.2 minutes, compared with 84 minutes for video-assisted minimal access parathyroidectomy. There was a high overall conversion rate (21 per cent), with the majority being converted to bilateral neck exploration, although 12 (17 per cent) video-assisted minimal access parathyroidectomy patients were salvaged with a conversion to open minimal incision parathyroidectomy. Success rates were 95.59 per cent for video-assisted minimal access parathyroidectomy and 97.33 per cent for open minimal incision parathyroidectomy (a statistically insignificant difference). As predicted, scar lengths for the shorter open minimal incision parathyroidectomy incision were comparable to those for video-assisted minimal access parathyroidectomy; hence, so was cosmetic satisfaction. There was no significant difference in post-operative pain, and complication rates were similar.

Discussion

The findings of this systematic review are summarised in Table II. It was accepted by all authors, and shown by all studies, that the three major methods of minimal access surgery (i.e. Miccoli video-assisted minimal access parathyroidectomy, Henry video-assisted minimal access parathyroidectomy and open minimal incision parathyroidectomy) had no significant differences regarding success or failure, compared

TABLE II
SUMMARY OF EVIDENCE

Study	Type	Purpose	Results	Evidence level
Various	Various case series	Present outcomes of various VAP & OMIP techniques	VAP & OMIP feasible & successful alternatives to BNE	4
Miccoli *et al.*[14]	Small RCT	VAP + qIOPTH *vs* BNE	Duration: VAP < BNE Post-op pain: VAP < BNE Cosmetic satisfaction: VAP > BNE	1b
Henry *et al.*[10]	Cohort study	VAP *vs* BNE	Success: VAP = BNE Analgesia: VAP < BNE	2b
Bergenfelz *et al.*[36]	RCT	OMIP-LA *vs* BNE-GA	Success: OMIP = BNE Duration: OMIP < BNE	1b
Barczynski *et al.*[37]	RCT	VAP *vs* OMIP	Success: VAP = OMIP Duration: VAP = OMIP Pain: VAP < OMIP Scar length: VAP < OMIP	1b
Barczynski *et al.*[38]	RCT	VAP *vs* OMIP	Success: VAP = OMIP Pain: VAP < OMIP Scar: VAP < OMIP	1b
Miccoli *et al.*[27,39]	RCT	VAP *vs* endo BNE	Success: VAP = endo BNE	1b
Slepavicius *et al.*[40]	RCT	OMIP *vs* BNE	Duration: OMIP < BNE Pain: OMIP < BNE Scar: OMIP < BNE	1b
Bergenfelz *et al.*[36]	RCT	VAP *vs* OMIP	Success: VAP = OMIP Scar: VAP < OMIP Pain: VAP = OMIP	1b

VIP = video-assisted parathyroidectomy; OMIP = open minimal incision parathyroidectomy; BNE = bilateral neck exploration; RCT = randomised, controlled trial; qIOPTH = quick intra-operative parathyroid hormone monitoring; GA = general anaesthesia; LA = local anaesthesia

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with the gold standard method of bilateral neck exploration, but only when the solitary adenoma had been localised on pre-operative imaging. Success rates ranged from 95.6 to 100 per cent for minimally invasive parathyroidectomy, compared with a mean of 97.7 per cent for bilateral neck exploration in one case series.[41] Some papers, particularly the 2010 paper by Bergenfelz *et al.*,[36] highlighted an issue with these quoted figures. In most of the other studies, performed in specialist centres by experienced, pioneering surgeons, the conversion rate to bilateral neck exploration was relatively low (conversion was normally only required for multiglandular disease). However, in the last randomised, controlled trial, which included results from numerous Swedish and Danish surgeons of varying experience, the conversion rates were much higher (approximately 21 per cent overall); the reasons included difficulty with the technique and problems with gland localisation. This suggests that both minimally invasive parathyroidectomy techniques require extensive practice before proficiency is achieved.

Minimally invasive parathyroidectomy was shown in all studies to have similar complication rates to standard bilateral neck exploration. Observed complications for minimally invasive parathyroidectomy included transient hypocalcaemia, transient recurrent laryngeal nerve palsy (and one case of permanent recurrent laryngeal nerve palsy due to video-assisted minimal access parathyroidectomy), wound infection and haematoma, and these were more or less constant across techniques. Some of the case series reporting on CO_2 insufflation dependent video-assisted minimal access parathyroidectomy also drew attention to subcutaneous emphysema as a potential complication, although this appears to have become less of a problem with gas-less and low pressure techniques. It has been suggested that the rate of transient recurrent laryngeal nerve palsy should be lower with video-assisted minimal access parathyroidectomy, due to a magnified image and easier nerve localisation, but the evidence has failed to reflect this theory.

Post-operative pain and analgesia requirements may be lower for minimally invasive parathyroidectomy compared with bilateral neck exploration. This is thought to be due to a combination of the surgical neck position and the psychological effect of surgical invasiveness. Scar length outcomes are also better for minimally invasive parathyroidectomy, although long term cosmetic satisfaction has not been shown to be significantly better for bilateral neck exploration compared with minimally invasive parathyroidectomy. This is probably because the collar incision of bilateral neck exploration is easily disguisable, and also due to the attitudes prevalent in the age group of the average patient.

Results for operative times are conflicting, although the general trend suggests that operative times for minimally invasive parathyroidectomy are significantly less than those for bilateral neck exploration. However, the inclusion of intra-operative parathyroid hormone monitoring can add as much as 30 minutes to the operative time.

The papers comparing open minimal incision parathyroidectomy to video-assisted minimal access parathyroidectomy gave conflicting results. Initial studies by Barczynski *et al.* suggested that pain scores and scar length were reduced in video-assisted minimal access parathyroidectomy patients. However, Bergenfelz *et al.* showed that open minimal incision parathyroidectomy could be performed via a similar incision length to video-assisted minimal access parathyroidectomy. Based on the evidence, it is likely that video-assisted minimal access parathyroidectomy is superior in terms of reduced post-operative pain, whilst open minimal incision parathyroidectomy requires a shorter operation and also has a shorter learning curve for surgeons. Several papers[37,40] have also discussed the fact that open minimal incision parathyroidectomy is the more cost-effective option.

Conclusions

There is level 1b evidence that Miccoli technique video-assisted minimal access parathyroidectomy and open minimal incision parathyroidectomy are feasible and comparable alternatives to bilateral neck exploration. There is level 2b evidence that Henry technique video-assisted minimal access parathyroidectomy is comparable. Furthermore, based on level 1b evidence, minimally invasive parathyroidectomy is superior to bilateral neck exploration in terms of post-operative pain, scar length and duration of surgery.

Thus, this review recommends that, due to benefits regarding operation duration, surgeon learning curve and cost-effectiveness, open minimally invasive parathyroidectomy is the treatment of choice for sporadic primary hyperparathyroidism due to a solitary adenoma, in the majority of healthcare centres.

Conversely, video-assisted parathyroidectomy may have significantly better post-operative pain outcomes, and is comparable in duration to open minimal incision parathyroidectomy when performed by experienced surgeons. As a result, this technique may be preferable in specialised, better funded centres, and could be the method taught to the next generation of surgeons.

Better structured and administered randomised, controlled trials, with fewer variables, may be beneficial to fully clarify this point, and to distinguish between the Miccoli and Henry techniques of video-assisted minimal access parathyroidectomy.

As a side-note, there does not appear to be any good evidence for the use of minimally invasive parathyroidectomy in cases of multiglandular disease, parathyroid carcinoma or sporadic primary hyperparathyroidism with negative localisation; thus, in these cases bilateral neck exploration should remain the technique of choice. More research would be required if minimally invasive parathyroidectomy were to be considered for use in such cases.

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