World J. Surg. 24, 1442–1445, 2000
DOI: 10.1007/s002680010238

WORLD
Journal of
SURGERY

Minimal Incision Parathyroidectomy: Cure, Cosmesis, and Cost

Jennifer K. Lowney, M.D.,[1] Beverly Weber, R.N.,[2] Shirley Johnson, R.N., M.B.A.,[2] Gerard M. Doherty, M.D.[1]

[1]Section of Endocrine and Oncologic Surgery, Washington University School of Medicine, One Barnes Hospital Plaza, Suite 8109, St. Louis, Missouri 63110, USA
[2]Oncology Services, Barnes Jewish Hospital, 216 North Kingshighway, St. Louis, Missouri 63108, USA

Abstract. The goals of operative treatment of primary hyperparathyroidism are (1) cure; (2) minimal invasion; and (3) cost-effectiveness. The optimal strategy is controversial. Retrospective review of was undertaken 66 previously unoperated patients having minimal-incision, full-neck exploration by one surgeon over 29 months. A group of 51 women and 15 men had open full neck exploration under general anesthesia through a small (25–40 mm) incision using specifically selected instruments; patients remained hospitalized overnight. Preoperative sestamibi scans were obtained before referral for 17 patients: 11 had localized disease, and 6 did not (65% sensitivity). Four parathyroid glands were identified in 98% of patients; intraoperative frozen section was used selectively on a median of one gland per patient. About 76% of patients had single-gland disease, 6% had two-gland disease, and 18% had four-gland hyperplasia. One patient had four normal cervical parathyroid glands and an aortopulmonary window parathyroid adenoma resected at thoracotomy 1 week later; preoperative sestamibi scans failed to localize his disease. There were no nerve injuries and a 98% cure rate after initial cervical exploration. Excluding the cost of the sestamibi scans, there was no difference between those who had preoperative localization and those who did not; 60% of hospital costs were operating room time-related. Minimal-incision parathyroidectomy is effective for curing hyperparathyroidism and has excellent cosmetic results with negligible scar. Preoperative sestamibi scanning had no impact on cure or treatment costs. Strategies to improve cost-effectiveness must address the substantial costs of anesthesia and operating room services.

Controversy exists regarding the optimal approach to operative management of primary hyperparathyroidism. The standard bilateral neck exploration allows identification of pathology and normal anatomy, with the highest cure rate in the hands of an experienced surgeon. Bilateral neck exploration allows the highest curative rate but with the greatest theoretic incidence of morbidity due to nerve damage, permanent hypoparathyroidism, and poor cosmesis. Attempts to improve cosmesis and reduce morbidity and cost associated with this procedure have led to attempts to modify the standard approach without sacrificing the high curative rate associated with bilateral neck exploration. The utility and sensitivity of preoperative localization studies (PLSs) to accurately direct a unilateral exploration for better cosmesis have been controversial [1–6]. The increased risks and costs of reexploration due to unsuccessful initial surgery for primary hyperparathyroidism have also been evaluated [7]. We hypothesize that minimal-incision full-neck exploration is still a highly successful option with excellent cure rates and minimal morbidity. This approach requires no PLSs and has good cosmesis using a minimal incision (2.5–4.0 cm compared to a unilateral exploration incision of 2–3 cm) without the added costs of PLS and risk of reexploration.

This International Association of Endocrine Surgeons (IAES) article was presented at the 38th World Congress of Surgery International Surgical Week (ISW99), Vienna, Austria, August 15–20, 1999.
Correspondence to: G.M. Doherty, M.D.

Methods

The data are from a retrospective review of 66 patients who had minimal-incision, full-neck exploration for primary hyperparathyroidism by one endocrine surgeon over 29 months. Patients with previous neck explorations were excluded. Patient records from 66 parathyroidectomies performed by one surgeon between June 1997 and June 1999 were reviewed to obtain demographics, biochemical and clinical diagnostic tests, and follow-up documentation. All preoperative localization studies were performed prior to referral but were reviewed by the surgeon and radiology staff. The surgical strategy included general anesthesia, bilateral exploration through a minimal incision, recurrent laryngeal nerve identification, and identification of four glands. All patients remained in hospital overnight for observation. Cost data were obtained from the BJC billing system database, and cost analysis was based on cost per charge ratio. The costs of PLS were not included in the cost analysis as most studies were performed at outside facilities.

Results

Chart review of 66 patients revealed data for 15 men and 51 women with no previous neck exploration who underwent 66 open full-neck explorations for primary hyperparathyroidism by one surgeon between June 1997 and June 1999 (Table 1). There were 61 cases of sporadic hyperparathyroidism (92%) and five patients with multiple endocrine neoplasia type I (MEN-I) with a median age of 57 years at the time of operation. Altogether, 39 patients were either asymptomatic or had nonspecific symptoms, and 27 patients had objective effects of primary hyperparathyroidism (9 with nephrolithiasis, 16 with documented osteoporosis by densitometry, 1 with hypercalcemic crisis, and 1 with peptic ulcer disease). Primary hyperparathyroidism is biochemically docu-

Table 1. Clinical characteristics.

Characteristic	Result
Age (years)	57 (28–87)
Gender	
Female	51
Male	15
Presentation	
Asymptomatic/subjective symptoms	39
Complications	27
Nephrolithiasis	9
Osteoporosis[a]	16
Calcium crisis	1
Preoperative serum calcium level (mg/dl)	10.9 (9.4–12.9)
Intact parathyroid hormone level (pg/ml)	104 (43–828)
Serum phosphorus (mg/dl)	2.8 (1.7–3.9)
Urinary calcium levels (mg/24 hr), $n = 20$	298 (68–449)
Ionized calcium levels (mg/dl), $n = 35$	5.8 (5.04–7.12)

Results are medians and ranges.
[a]Diagnosed by lumbar densitometry.

Table 2. Preoperative localization studies.

Study	No.	Sensitivity
Sestamibi scans	17	65% (11/17)
Ultrasonography	4	25% (1/4)
CT scan	3	33% (1/3)
MRI	1	0%

Altogether, 25 studies were performed on 19 patients.
CT: computed tomography; MRI: magnetic resonance imaging.

Table 3. Operative results.

Incision size (cm)	4 (2.5–6.0)
Weight of abnormal glands (mg)	276 (130–5314)
No. of glands identified	4 (3–5)
No. of glands biopsied	1 (1–4)

Results are medians and ranges.

Table 4. Postoperative results.

Parathyroid pathology (no.)	
Solitary adenoma[a]	50 (76%)
Multigland hyperplasia	12 (18%)
Double adenoma	4 (6%)
Calcium levels (mg/dl)	
Postoperative	8.8 (7.8–12.2)
One-month follow-up	9.4 (7.2–10.6)
Complications	
Recurrent nerve injury	0
Persistent hypoparathyroidism[b]	2
Persistent hyperparathyroidism[c]	1

Results for calcium levels are medians and ranges.
[a]One ectopic gland.
[b]Both patients have multiple endocrine neoplasia type I (MEN-I) treated with total parathyroidectomy with autotransplantation.
[c]Resolved after thoracotomy for aortopulmonary window adenoma.

Table 5. Cost analysis.

Length of stay[a]	1.0 (1.0–15)
Costs[b]	
Operating room	$1598 ($1206–$3143)
Surgical pathology	$261 ($59–$3733)
Anesthesia	$318 ($143–$456)
Recovery room	$227 ($157–$568)
Room/board	$526 ($395–$8031)
Total	$3630 ($2537–$20,825)

[a]Median days (range).
[b]Median costs based on cost per charge ratio (ranges).

mented by elevated serum calcium levels (median 10.9 mg/dl) and a median intact parathyroid hormone (iPTH) level of 104 pg/ml. Urinary calcium levels were performed in 20 patients with a median level of 298 mg/24 hr. Twenty-five preoperative studies were obtained before surgical referral for 19 patients; only 13 had localized disease, and 12 did not. Seventeen technetium-99m (^{99m}Tc)-sestamibi scans were performed, with only 11 (65% sensitivity) of these studies localizing unilateral disease (Table 2). Neck ultrasonography (US) identified one adenoma in four patients. Neck computed tomography (CT) had only a 33% sensitivity. One patient had neck magnetic resonance imaging (MRI) performed in combination with the three other studies, which did not detect the adenoma found at the time of operation. Three patients had multiple studies that did not increase the sensitivity of detection of adenomas.

The median incision length was 4 cm, with only patient requiring extension of their incision for exposure (Table 3). Four parathyroid glands were identified in 98% of patients; intraoperative frozen section was used selectively, on a median of one gland per patient. About 78% of patients had single-gland disease, 6% had two-gland disease, and 16% had four-gland hyperplasia (Table 4). There were no parathyroid carcinomas. One patient had four normal cervical parathyroid glands and an aortopulmonary window parathyroid adenoma resected at thoracotomy 1 week later; a preoperative sestamibi scan failed to localize his disease. This was the only ectopic gland found in this review. Normocalcemia was achieved in 95% (63/66) of patients after the initial cervical exploration. There were no nerve injuries.

Two patients have persistent hypoparathyroidism. These two patients have MEN-I syndrome, and each underwent total parathyroidectomy with parathyroid autograft. They each remain on calcium supplementation. Only 1 of the 66 patients (98%) had persistent hyperparathyroidism, which was successfully treated by left thoracotomy.

All patients stayed overnight under observational status, with eight patients staying more than 2 days secondary to either prior admission or treatment of co-morbidities. Analysis of the costs associated with operative management of primary hyperparathyroidism showed that 60% of the cost of the total hospital charge was due to operative charges (Table 5). There was a median cost of $2404 per patient, covering the operating room, surgical pathology, anesthesia, and recovery room fees. There was no significant difference or substantial cost reduction in operative costs between patients who had successful PLS and those who did not undergo PLS.

Discussion

There has been continued controversy about the initial operative management of primary hyperparathyroidism. Proponents of the standard bilateral neck exploration with identification of all four glands argue that it is a safe technique with the highest cure rate

and low morbidity in the hands of an experienced surgeon. Attempts to reduce costs without sacrificing the success of this standard procedure have had mixed results [3, 4, 7–9]. Studies have examined the role of minimally invasive techniques including (1) use of PLS for unilateral exploration with or without intraoperative PTH monitoring [3, 4, 5, 6, 10]; (2) use of intraoperative ultrasonography or PTH monitoring [9, 10]; (3) local anesthesia/outpatient surgical treatment using any of these strategies [8, 11, 12]; and (4) operative endoscopy [13, 14].

Proponents of a unilateral, directed neck exploration argue that this approach decreases costs and the risk of morbidity while improving cosmesis. However, the performance of unilateral neck exploration directed by the results of PLS may increase the failure rate of operative management owing to the lack of sensitivity observed in previous studies, particularly for multiple gland disease (22% in this series). In addition, patients with negative PLS then have the conventional exploration anyway. Hence this unilateral approach may minimally improve cosmesis (a 2- to 3-cm incision versus a 2.5- to 4.0-cm incision) at the expense of increasing the costs associated with PLS and possibly by adding the costs and risks of reexploration.

Minimal incision, bilateral neck exploration with identification for all four glands, and selective use of surgical pathology for confirmation has allowed this approach to address some of the issues associated with the standard approach. This technique was shown here to be effective (98% cure rate) and safe. The cosmesis achieved with the small incision was excellent. PLS in the patients referred had poor sensitivity (probably due in part to a referral selection bias) and only added to the cost of the patient's episode of care. Cost analysis showed that a substantial portion of the cost of operative management was the operating room charges.

This procedure is an effective technique with minimal morbidity and maximal cure rate for primary hyperparathyroidism. Further attempts to reduce the substantial costs of this highly successful, safe operation should focus on the operating room and anesthesia costs.

Résumé

Fond du problème: Les buts du traitement opératoire de l'hyperparathyroïdie primitive sont: (1) la cure; (2) mini-invasion; et (3) coût-efficacité. La stratégie optimale est controversée. Méthodes: Une revue retrospective de 66 patients, opérés pour la première fois, ayant eu une exploration complète du cou par une incision à minima, par un seul chirurgien pendant une période de 29 mois. Résultats: 51 femmes et 15 hommes ont eu une exploration complète du cou sous anesthésie générale par une court (25–40 mm) incision avec des instruments sélectionnés, spécifiques; les patients ont été hospitalisés une nuit. On a obtenu des scintigraphie «sestamibi» préopératoirement pour 17 patients; 11 avaient une maladie localisée, 6 n'en avait pas (sensibilité de 65%). Quatre glandes parathyroïdes ont pu être identifiées chez 98% des patients; L'examen extemporané a été utilisé de façon sélective, pour une glande (médiane) par patient. 76% des patients avaient une seuls glande malade, 6% avaient deux glandes maladies et 18% avaient une hyperplasie des quatre glandes. Un patient avait quatre glandes cervicales normales mais on a réséqué un adénome parathyroïdien situé dans la fenêtre aortopulmonaire par thoracotomie une semaine plus tard; une scintigraphie préopératoire au sestamibi n'avait pas localisé sa maladie. Il n'y a eu aucune lésion nerveuse et on a obtenu un taux de guérison de 98% après l'exploration cervicale initiale. Si on exclue les coûts de la scintigraphie sestamibi, il n'y avait aucune différence entre ceux qui avaient une localisation préopératoire et ceux qui n'en ont pas eu; 60% deds coûts hospitaliers étaient en rapport avec le temps d'occupation de la salle d'opération. Conclusion: La parathyroïdectomie par une mini-incision guérit effectivement l'hyperthyroïdie et fournit d'excellents résultats esthétiques avec une cicatrice négligeable. La scintigraphie préopératoire sestamibi n'a eu aucun impact sur la guérison ou le traitement. Les stratégies pour améliorer le coût-efficacité doivent inclure les coûts importants de l'anesthésie et le temps d'occupation des salles.

Resumen

Antecedentes: Los objetivos del tratamiento quirúrgico del hiperparatirodismo primario son: 1) curar al enfermo, 2) operación mínimamente invasiva, 3) costo/eficacia. La mejor estrategia para conseguir estos fines sigue siendo controvertida. Métodos: Se efectúa un estudio retrospectivo que comprende 66 pacientes operados mediante incisión mínima, con exploración completa del cuello, por un solo cirujano en un periodo de tiempo de 29 meses. Resultados: Bajo anestesia general se realizó en 51 mujeres y 15 hombres una exploración completa de cuello, a través de una incisión mínima (25–40 mm) utilizando un instrumental especialmente ideado para esta intervención. Los pacientes permanecieron hospitalizados sólo la noche siguiente a la operación. La prueba diagnóstica preoperatoria en 17 casos fue el sestamibi; en 11 casos dicha prueba permitió el diagnóstico de localización, fracasando en 6, por lo que la sensibilidad fue del 65%. En el 98% de los pacientes se identificaron 4 glándulas paratiroideas. La biopsia intraoperatoria por congelación se realizó de forma selectiva, con una media de una glándula por paciente. En el 76% de los casos sólo estaba afectada una glándula, en el 6% 2 y en el 18% las 4 glándulas estaban hiperplásicas. En un enfermo con 4 paratiroides normales, se resecó una semana más tarde, mediante toracotomía, un adenoma paratiroideo aorto-pulmonar; el sestamibi preoperatorio no fue capaz de detectar la lesión. No se produjeron lesiones nerviosas y la tasa de curación tras la exploración cervical inicial fue del 98%. Excluyendo el coste de los escintigramas preoperatorios (sestamibi) no hubo diferencia alguna entre aquellos que fueron intervenidos con diagnóstico preoperatorio de localización y los que no fueron previamente diagnosticados. El 60% del costo hospitalario se debe al tiempo de utilización del quirófano. Conclusión: La paratiroidectomía mínimamente invasiva es efectiva para el tratamiento curativo del hiperparatirodismo, proporcionado excelentes resultados cosméticos con cicatrices insignificantes. La escintigrafía preoperatoria con sestamibi no tiene efecto alguno, ni por lo que a la curación, ni por lo que a los costes, se refiere. Para mejorar la relación costo/eficacia han de disminuirse los gastos de la anestesia y de los servicios de quirófanos.

References

1. Mitchell, B.K., Merrell, R.C., Kinder, B.K.: Localization studies in patients with hyperparathyroidism. Surg. Clin. North Am. *75*:483, 1995

2. Shen, W., Sabanci, U., Morita, E.T., Siperstein, A.E., Duh, Q.Y., Clark, O.H.: Sestamibi scanning is inadequate for directing unilateral neck exploration for first-time parathyroidectomy. Arch. Surg. *132*: 969, 1997
3. Denham, D.W., Norman, J.: Cost-effectiveness of preoperative sestamibi scan upon the surgeon's choice of operative procedure. J. Am. Coll. Surg. *186*:293, 1998
4. Borley, N.R., Collins, R.E.C., O'Doherty, M., Coakley, A.: Technetium-99m sestamibi parathyroid localization is accurate enough for scan-directed unilateral neck exploration. Br. J. Surg. *83*:989, 1996
5. Chapuis, Y., Fulla, Y., Bonnichon, P.: Values of ultrasonography, sestamibi scintigraphy, and intraoperative measurement of I-84 PTH for unilateral neck exploration of primary hyperparathyroidism. World J. Surg. *20*:835, 1996
6. Roe, S.M., Brown, P.W., Pate, L.M., Summitt, J.B., Ciraulo, D.L., Burns, R.P.: Initial cervical exploration for parathyroidectomy is not benefited by preoperative localization studies. Am. Surg. *64*:503, 1998
7. Doherty, G.M., Weber, B., Norton, J.A.: Cost of unsuccessful surgery for primary hyperparathyroidism. Surgery *116*:954, 1994
8. Norman, J., Chheda, H., Farrell, C.: Minimally invasive parathyroidectomy for primary hyperparathyroidism: decreasing operative time and potential complications while improving cosmetic results. Am. Surg. *64*:391, 1998
9. Norman, J., Chheda, H.: Minimally invasive parathyroidectomy facilitated by intraoperative nuclear mapping. Surgery *122*:998, 1997
10. Carty, S.E., Worsey, J., Viriji, M.A., Brown, M.L., Watson, C.G.: Concise parathyroidectomy: the impact of preoperative SPECT ^{99m}Tc sestamibi scanning and intraoperative quick parathormone assay. Surgery *122*:1101, 1997
11. Irvin, G.L., Sfakianakis, G., Yeung, L., Deriso, G.T., Fishman, L.M., Molinari, A.S., Foss, J.N.: Ambulatory parathyroidectomy for primary hyperparathyroidism. Arch. Surg. *131*:1074, 1996
12. Ditkoff, B.A., Chabot, J., Feind, C., LoGerfo, P.L.: Parathyroid surgery using monitored anesthesia care as an alternative to general anesthesia. Am. J. Surg. *172*:698, 1996
13. Anitoh, T., Gagner, M., Garcia-Ruiz, A., Heniford, B.T.: Endoscopic endocrine surgery in the neck: an initial report of endoscopic subtotal parathyroidectomy. Surg. Endosc. *12*:202, 1998
14. Miccoli, P., Bendinelli, C., Vignali, E., Mazzeo, S., Cecchini, G.M., Pinchera, A., Marcocci, C.: Endoscopic parathyroidectomy: report of an initial experience. Surgery *124*:1077, 1998