

Thoracoscopic Removal of Mediastinal Hyperfunctioning Parathyroid Glands: Personal Experience and Review of the Literature

P. F. Alesina · D. Moka · J. Mahlstedt ·
M. K. Walz

Published online: 7 December 2007
© Société Internationale de Chirurgie 2007

Abstract

Background The presence of a mediastinal hyperfunctioning parathyroid gland is a rare condition that occurs in about 1% to 2% of cases. We present our experience with video-endoscopic parathyroidectomy and a review of the literature.

Methods In seven patients (four male, three female; age 28–67 years) mediastinal hyperfunctioning parathyroid glands were removed by the thoracoscopic route (VATS). Six patients suffered from primary hyperparathyroidism and one woman from recurrent secondary hyperparathyroidism. Additionally, articles concerning endoscopic treatment of mediastinal parathyroid glands were collected from the medical databases. A total of 58 patients were found in the English and French literature.

Results Neither intraoperative nor postoperative complications occurred in our patients. Operating time was 90 minutes (range 40–180 minutes). After a mean follow-up of 29 ± 12 months (range 3–64), all patients are biochemically cured. The cases in the literature showed healing in 57 of 58 cases. Their mean operating time was 112 minutes (range 40–240 minutes). One perioperative death due to myocardial infarction and a major complications rate of 7% are described.

Conclusion The thoracoscopic approach to mediastinal parathyroidectomy is a safe, feasible technique with a low complication rate and good cosmetic outcome. It should become the standard surgical access for mediastinal hyperfunctioning parathyroid glands.

Approximately 95% of patients with sporadic primary hyperparathyroidism are cured at initial neck exploration performed by an experienced surgeon without preoperative localization studies or specialized intraoperative technology [1, 2]. However, introduction into clinical practice of technetium-sestamibi scanning, the intraoperative parathormone measurement (ioPTH), and videoscopic neck operations have prompted surgeons to use alternatives to the standard approach.

One reason for pitfalls at the first operation is the ectopic location of the parathyroid lesion. Most abnormal parathyroid glands are found in the superior mediastinum within the thymus and can be removed through a cervical incision [3]. Occasionally, in 1% to 2% of patients, the parathyroid migrates deep into the mediastinum or chest being inaccessible through the neck. In these cases, thoracic approaches as thoracotomy, median sternotomy, or thoracoscopy are required. As expected, those conventional open procedures have a high complication rate and a long recovery time [4–6]. In 1994, Prinz et al. [7] performed the first thoracoscopic removal of a mediastinal ectopic hyperfunctioning parathyroid gland. Meanwhile, this minimally invasive approach for mediastinal parathyroidectomy has also been reported by others, mainly as case reports or in small series [8–35]. Because of the rarity of the disease, personal experiences are limited, and final assessments have not been possible.

In this article we report our experience with thoracoscopic parathyroidectomy performed in seven cases.

P. F. Alesina (✉) · M. K. Walz
Clinic of Surgery and Centre of Minimally Invasive Surgery,
Kliniken Essen-Mitte, Evang. Huyssens-Stiftung, Akademisches
Lehrkrankenhaus der Universität Duisburg-Essen, Henricistrasse
92, D-45136 Essen, Germany
e-mail: pieroalesina@libero.it

D. Moka · J. Mahlstedt
Institute for Radiology and Nuclear Medicine, Henricistrasse 40,
D-45136 Essen, Germany

Moreover, we reviewed the literature with the intent to present the state of art of minimally invasive mediastinal parathyroidectomy, discussing diagnostic modalities, indications, and technique.

Materials and methods

Between February 2002 and April 2007, a total of 217 patients with hyperparathyroidism were operated on at our institution. During the same period, because of our special interest in this topic and in minimally invasive surgery, seven patients (four men, three women) with a mean age of 47 ± 18 years (range 28–67 years) were referred to us because of ectopic mediastinal hyperparathyroidism (Table 1). Six of them suffered from primary hyperparathyroidism (pHPT), and one woman suffered from recurrent secondary hyperparathyroidism (sHPT). One patient affected by primary hyperparathyroidism had had a previous neck exploration with resection of three hyperplastic glands. The left inferior parathyroid was missed. In the other five patients, primary hyperparathyroidism had not been treated before. A 67-year-old woman suffered from sHPT after a bilateral neck exploration with resection of three glands; she had already undergone two cardiac operations through a left thoracotomy and a median sternotomy. The two patients already operated on had also undergone transcervical thymectomy as part of the first operation.

In all patients the mediastinal location of the gland was confirmed by scintigraphy (^{99m}Tc sestamibi) and computed tomography (CT). ^{99m}Tc sestamibi scanning, which showed a single lesion in the mediastinum, was performed following negative findings of neck ultrasonography. CT scanning was additionally used to obtain anatomic details on the position of the gland. In all patients, the location of the gland was the anterior mediastinum at least 5 cm below the sternal notch. The anatomic position below the brachiocephalic vein or the aortic arch, respectively, convinced us to choose the thoracoscopic approach. The decision was also based on our previous experience with a patient operated on through the neck in whom the procedure was unexpectedly difficult. The CT findings also allowed the surgeon to decide between left or right thoracoscopy.

The operations were performed under general anesthesia using a double-lumen endotracheal tube. Patients were placed in the lateral position. Three trocar sites were generally used except for one patient in whom a fourth trocar was necessary to retract the lung. We used two 5-mm trocars and one 10-mm trocar (fourth to eighth intercostal space) and all procedures were performed using a 5-mm 30° optic. The dissection was carried out using

a monopolar hook. After incision of the mediastinal pleura, the location of the parathyroid was identified on the basis of CT scan findings. The vascular pedicle was controlled by resorbable clips. The freed gland was placed in a plastic bag and removed through a port site. No chest tubes were used. Intraoperative parathyroid hormone (PTH) levels were monitored with a rapid assay to confirm the success of the procedure 15 minutes after resecting the hyperfunctioning gland.

Additionally, we reviewed the literature to search all the previous reports regarding thoracoscopic parathyroidectomy. The keywords “thoracoscopic parathyroidectomy” and/or “thoracoscopy and parathyroid” were used at PubMed (<http://www.ncbi.nlm.nih.gov>). All the data available were collected with the intent to analyze recent experiences concerning surgical technique, feasibility, and complications of mediastinal parathyroidectomy.

Results

In our seven patients the Tc-99m sestamibi scan (Fig. 1) showed abnormal uptake deep in the chest, and the CT scan (Fig. 2) confirmed the presence of mediastinal parathyroid tissue. Thoracoscopy offered a direct view on the anterior mediastinum and was successfully used four times on the left side and three times on the right side. No intraoperative complications occurred. The mean operating time was 90 ± 53 minutes (range 40–180 minutes). Because of concomitant evidence of mediastinal lymph node enlargement, the operating time for patient 3 was prolonged to 140 minutes. Moreover, due to the previous thoracic operations the operating time reached 180 minutes in patient 5. Nevertheless, all of the procedures were completed thoracoscopically. The intraoperative blood loss was minimal in all cases.

Two patients experienced a transient postoperative hypocalcemia requiring vitamin D substitution in one case (patient 4). The patients were mobilized the day of the operation, minimal postoperative pain; no patient required postoperative intravenous morphine administration. The mean hospital stay was 3.8 ± 1.3 days (range 2–6 days). Histology showed an adenoma in five patients and a parathyroid hyperplasia in two. After a follow-up of 29 ± 25 months (range 3–64 months), all patients are biochemically cured. The cosmetic outcome was excellent.

We reviewed 58 thoracoscopic parathyroidectomies described in the English and French literature (Table 2). There were 20 men and 27 women (sex was not available in 11 cases) with a mean age of 50 years (range 22–82 years). The preoperative diagnosis, known for 52 patients, was primary HPT in 42 cases and secondary HPT in the remaining 10. Thirty patients (52%) had a history of

Table 1 Characteristics of the patients

Parameter	Pt. 1	Pt. 2	Pt. 3	Pt. 4	Pt. 5	Pt. 6	Pt. 7
Age (years)/sex	33/M	28/M	39/M	34/M	67/F	67/F	66/F
Previous neck surgery	No	No	No	Yes	Yes	No	No
Diagnosis	PHPT	PHPT	PHPT	PHPT	SHPT	PHPT	PHPT
PTH, ^a preop. (pg/ml)	339	288	136	76	1800	442	252
Ca, preop. (mmol/L)	2.85	2.92	3.11	2.87	3.01	2.95	2.86
US ^b	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Scintiscan ^c	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CT ^d	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location of the tumor	Anterior mediastinum	Anterior mediastinum	Right to the ascending aorta	Left to the ascending aorta	Anterior mediastinum	Anterior mediastinum	Anterior mediastinum
Thoracoscopy approach	Left	Left	Right	Left	Right	Right	Left
Trocars (no.)	3	3	4	3	3	3	3
Operating time (min)	40	140	70	40	180	60	100
PTH, ^a postop. (pg/ml)	43	6.9	14	10	800	198	8
Ca, postop. (mmol/L)	2.19	2.24	2.33	2.09	2.42	2.38	2.30
Histology, size (mm)	Adenoma, 7	Adenoma, 23	Adenoma, 10	Hyperplasia, 12	Hyperplasia, 21	Adenoma, 15	Adenoma
Postop. complication	None	None	Hypocalcemia	Hypocalcemia	None	None	None
Hospital stay (days)	4	5	6	3	4	2	3
Follow-up (months)	64	57	44	19	9	5	3

US, ultrasonography; CT, computed tomography; PHPT, primary hyperparathyroidism; SHPT, secondary hyperparathyroidism; PTH, parathyroid hormone; Ca, calcium

^a Normal: 10–55 pg/ml

^b US results were negative in all of the patients

^c Scintiscans were positive in all patients

^d CT scans were positive in all patients



Fig. 1 Computed tomography scan showing a parathyroid adenoma left to the ascending aorta in patient 2

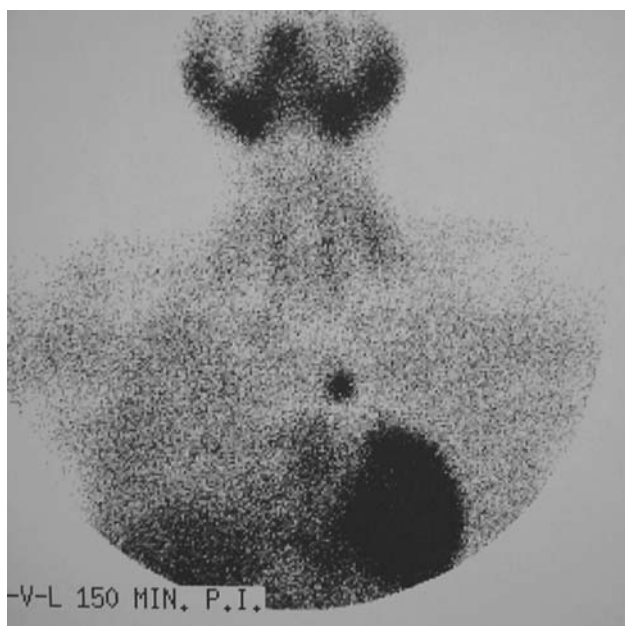


Fig. 2 Sestamibi scan reveals increased tracer concentration in the anterior mediastinum of patient 2

previous neck exploration. Preoperative localization studies, when described, included CT in 43 cases, magnetic resonance imaging (MRI) in 9, and scintigraphy in 47 patients. The most common location of the tumor was the anterior mediastinum close to the root of the ascending aorta. In 10 cases the gland was removed from the aortopulmonary window.

Thoracoscopy was performed from the left side in 22 cases and from the right side in 19, no side was mentioned in 17 cases. The mean operating time, mentioned in 24 cases, was 112 minutes (range 40–240 minutes). Three cases of concomitant thoracoscopy and standard cervical

exploration were reported. No intraoperative complications were registered. Intraoperatively, the gamma probe was used in nine cases and endoscopic ultrasonography once. One case of robot-assisted thoracoscopy was also described [26]. A chest tube was used in 25 cases and was removed within the first postoperative day except for one patient in whom it was removed after 9 days because of an eosinophilic pleural effusion [14]. In all patients, postoperative blood levels of calcium and PTH returned to normal.

One patient had a negative thoracic exploration, and a subsequent extended cervical exploration identified an adenoma in the neck [35]. Histology showed a parathyroid adenoma in 38 cases and parathyroid hyperplasia in 6 cases. No pathologic details are reported for 14 patients. Postoperative major complications included two cases of documented transient recurrent nerve palsy [29, 35] and one case of definitive hypoparathyroidism after 3 + ½ parathyroidectomy and subsequent thoracoscopic parathyroidectomy for persistent disease [23]. In one patient, an eosinophilic pleural effusion developed on the third postoperative day; this patient required a repeated thoracoscopy for massive intrathoracic hemorrhage and hemostasis of the bleeding site at the parietal pleura 38 days after the first operation [14]. One patient with a preoperative diagnosis of secondary hyperparathyroidism died owing to myocardial failure 5 days after the procedure [12]. A case of slight hypocalcemia that normalized within 3 days [10], one case of intercostal neuralgia that resolved within 2 weeks [17], and one case of transient hoarseness [25] were also described. A case of postoperative small apical pneumothorax is recently reported [32]. The mean hospital stay was 4 days (range 1–14 days)—reported in 34 cases. During the follow-up available for 25 patients affected by primary HPT (range 1–42 months) no recurrences were reported. This occurred in one patient with secondary HPT 9 months after the operation. The same patient died of cardiac failure 14 months later without further localization of parathyroid tissue, and even autopsy did not show residual disease [7].

Discussion

Although 15% to 20% of parathyroid glands have abnormal position [36], they can usually be removed through a cervical incision [2]. However, 1% to 2% of patients with hyperparathyroidism have a deep mediastinal parathyroid requiring a transsternal or transthoracic approach. We report our experience with video-endoscopic removal of mediastinal hyperfunctioning glands. Moreover, we reviewed the international literature to collect all reported cases of thoracoscopic parathyroidectomy. This surgical approach seems to offer certain advantages compared with

Table 2 Thoracoscopic parathyroidectomy: review of the literature

Study	No. of pts.	Age (years)	Sex	Previous neck surgery	Preoperative Studies: CT/MRI/MIBI	Thoracoscopy side (left or right)	OT (min)	Drainage	Complication	Hospital stay (days)	Follow-up (mo)
Prinz (1994)	4	52 (26–82)	2 M	Yes (4)	Yes/yes/yes (4)/(1)/(4)	L (4)	195 (120–240)	Yes (4)	No	4 (1–6)	12 (8–24)
Smythe (1995)	2	57	2 F	Yes	No/yes/yes	L	–	Yes	No	3	1
Gullstrands (1996)	1	55	F	No	Yes/no/no	R	–	Yes	No	3	1
Furrer (1996)	1	67	F	No	Yes/no/no	R	–	Yes	No	3	–
Peix (1996)	1	45	M	Yes	Yes/no/yes	R	–	–	HypoCa	–	36
DiBisceglie (1997)	1	61	F	No	Yes/no/yes	–	–	–	No	5	2
	2	58	F	Yes	Yes/no/yes	–	–	–	No	–	12
		64	M	Yes	Yes/no/yes	–	–	–	1 Death	–	Died ^a
Knight (1997)	2	71	M	Yes	Yes/no/yes	L	–	–	No	3	–
		39	F	Yes	Yes/no/yes	–	–	–	No	4	–
Inoue (1998)	1	64	M	Yes	No/yes/no	L	–	Yes	Yes ^a	–	–
Lesser (1999)	2	58	M	Yes	Yes/no/yes	L ^b	–	Yes	No	3	–
		42	F	No	Yes/no/yes	L	–	–	No	–	–
Oyama (1999)	1	45	–	–	–	–	–	–	–	–	–
Medrano (2000)	7	39 (22–57)	5 M	Yes (7)	Yes/yes/yes (7)/(2)/(7)	R (7)	65 (40–92)	Yes (5)	Yes (1) ^c	2.7 (2–3)	36 (15–42)
Yoshida (2001)	1	29	M	No	Yes/no/yes	R ^d	122	Yes	No	7	3
Ott (2001)	1	52	F	Yes	Yes/yes/yes	L ^e	–	–	No	5	1
Ishikawa (2002)	4	52 (23–73)	4 F	–	–/–/yes (4)	– ^{e/(1)}	98 (50–140)	–	No	–	–
O'Herrin (2002)	1	43	F	No	Yes/no/yes	L ^e	–	Yes	No	1	1
Cupisti (2002)	4	54 (26–79)	2 M	Yes (4)	Yes/yes/yes (2)/(1)/(3)	R (4)	–	–	Conver. (2)	6.7 (3–11)	–
Kumar (2002)	1	42	F	Yes	Yes/no/yes	R	90	Yes	No	6	6
Onoda (2002)	1	58	F	Yes	No/yes/yes	L ^e	50	–	No	14	–
Amar (2004)	3	58 (36–82)	3 F	No (3)	Yes/no/yes (3)/(3)/(3)	R (2) L (1)	–	–	Dysphonia (1)	–	21 (2) (12–31)
Profanter (2004)	1	57	F	No	Yes/no/yes	L	130	Yes	RLN Palsy	4	8
Quiros (2004)	1	32	M	Yes	Yes/no/yes	–	–	–	–	–	–
Kitami (2004)	1	46	M	–	Yes/_/_	–	120	–	–	–	–
Takashima (2005)	1	67	M	No	Yes/yes/no	L	–	–	–	6	–

Table 2 continued

Study	No. of pts.	Age (years)	Sex	Previous neck surgery	Preoperative Studies: CT/MRI/MIBI	Thoracoscopy side (left or right)	OT (min)	Drainage	Complication	Hospital stay (days)	Follow-up (mo)
Liu (2005)	3	59 (54–67)	1 M 2 F	Yes (2)	Yes/no/yes	L (2) ^e R (1) ^e	119 (81–145)	No	No	1	–
Nwariaku (2005)	2	–	–	–	–	–	–	–	–	–	–
Karpinski (2005)	1	55	F	No	No/yes/yes	L ^e	190	Yes	No	1	3
Weigel (2005)	4	–	–	Yes ^d (1)	Yes/no/yes (4)/(4)	L ^e (4)	–	Yes (4)	f	1	25
Taguchi (2006)	1	–	–	–	Yes/no/yes	–	–	–	No	–	–
Sukumar (2006)	3	–	–	–	Yes/no/yes (3)/(3)	(1) ^d	–	Yes (2)	RLN Palsy	2	–
Present Study	7	47 (28–7)	4M 3F	Yes (2)	Yes/no/yes (7)/(7)	L(4) R(3)	90 (40–180)	No	HypoCa (2)	3.8 (2–6)	29 (3–64)

MIBI, sestamibi; OT, operative time; RLN, recurrent laryngeal nerve

^a Eosinophilic pleural effusion and peripheral eosinophilia^b Endoscopic ultrasonography^c Intercostal neuralgia in one case^d One case of combined thoracic and cervical exploration^e Radio-guided thoracoscopy^f Neck exploration after failure in PTH decline

conventional open technique, such as thoracotomy and sternotomy. No major complications were observed in our series of seven patients; all the patients were cured; and the mean hospital stay was 3.8 days. The data available from the literature showed a complication rate of 7%, with one perioperative death.

Traditionally, the standard approaches to deep mediastinal parathyroids have been sternotomy or thoracotomy. The complication rate associated with these procedures is extremely high when compared with minimally invasive approaches and not acceptable in the era of endoscopic surgery. Russell et al. [4], in their series of 38 patients treated through a median sternotomy, reported a morbidity rate of 29%. In another series from Conn et al. [6], 4 of 21 patients treated by median sternotomy had complications, including two pleural effusion, a left subclavian vein thrombosis, and a case of chondritis of the xiphosternal junction. Cupisti and coworkers [22], in a series of 16 patients treated by the transsternal/trans thoracic approach, reported three cases of recurrent nerve palsy (18.7%), one case of chylus fistula (6.2%), and one case of pleural effusion (6.2%), with a mean hospital stay of 14 days. In contrast, no complications were registered and the mean hospital stay was 4.5 days in the two patients in whom thoracoscopy was successfully performed.

Alternative approaches to the mediastinal parathyroid has been proposed. Anterior mediastinotomy (parasternal or Chamberlain approach) has been described by Schlinkert et al. [37] and Kao and colleagues [38] recently reported a case of adenoma of the aortopulmonary window successfully removed through an upper partial sternotomy. A subxiphoidal laparoscopic approach has also been proposed, with successful removal of a mediastinal parathyroid [39]; however, it does not seem to offer any significant advantages over thoracoscopy and can be proposed only for lesions situated in the anterior mediastinum.

Nonsurgical options, such as angiographic ablation, have already been described. This approach consists of high-pressure injection of extra contrast material into the vessel, vascularizing the parathyroid and resulting in ischemic insult to the parenchyma. The largest series with the use of this technique was reported by Doherty et al. [40], who suggested that angiographic ablation be performed in patients whose parathyroid adenomas cannot be reached by standard neck incision, reserving median sternotomy or thoracotomy for patients in whom this technique fails. They performed 30 ablations in 27 patients, obtaining normocalcemia in 14 cases and hypoparathyroidism in 3. Further treatment was necessary in 10 cases (repeated ablation or surgical resection). No major complications were observed, and the patients experienced minimal pain. In another study, angioablation failed to control hyperparathyroidism in 40% [37]. Moreover, Nwariaku et al.

[31], in a recent series of four patients who underwent this procedure, reported two cases of neurologic complications (aphasia, confusion). They concluded that angiographic ablation should be avoided in patients with evidence of peripheral vascular disease due to a high risk of central embolism.

In our series, all patients had negative neck ultrasonography, and they were considered for surgery after Tc-99m imaging was performed. This strategy enabled us to avoid a negative neck exploration.

The success of thoracoscopy depends on accurate localization. The intraoperative use of a gamma probe could facilitate identification of parathyroid tissue, and its use was described in nine cases. As first described by Ott et al. [19], it can reduce unnecessary dissection and may decrease the operating time. Nonetheless, when a lesion is located in the mediastinum, accumulation of radioisotope in the myocardium could adversely affect navigation [20]. In our series, the operating time was prolonged to 140 minutes in one case owing to difficult dissection. Because of the location of the adenoma behind some enlarged lymph nodes, we do not believe that the use of a gamma probe would be helpful in reducing the operating time. Furthermore, as was also observed by Onoda et al. [24], most lesions can be identified precisely only from the video view.

Our data and the review of the literature suggest that thoracoscopic parathyroidectomy is a valid alternative to the standard “open” treatment of mediastinal hyperfunctioning parathyroid. Moreover, even if the gland is situated in the thymus, it can avoid the difficulties of a reintervention after an unsuccessful neck exploration. This procedure also provides direct visualization of the gland, potential access to the entire mediastinum, and preservation of parathyroid tissue in the event that autotransplantation is required. In addition, it is associated with a lower morbidity rate and requires a shorter hospital stay than thoracotomy or median sternotomy. It provides all the advantages of minimally invasive surgery (e.g., good cosmetic result and less postoperative pain), with an overall success rate that is 100% in our experience and 98% in the reviewed cases.

Conclusions

Thoracoscopic parathyroidectomy is a feasible, safe technique associated with few postoperative complications and excellent cosmetic outcome. Thoracoscopy should not be an exploratory procedure. Therefore, accurate preoperative functional and anatomic localization of the parathyroid, respectively, with scintigraphy and CT scan is essential. Thoracoscopy should become the standard approach for

hyperfunctioning parathyroid glands in the middle and lower mediastinum.

References

1. Van Heerden JA, Grant CS (1991) Surgical treatment of primary hyperparathyroidism: an institutional perspective. *World J Surg* 15:688–692
2. Kaplan EL, Yashiro T, Salti G (1992) Primary hyperparathyroidism in the 1990s. *Ann Surg* 215:300–317
3. Freeman JB, Sherman BM, Mason EE (1975) Transcervical thymectomy. *Arch Surg* 111:359–364
4. Russell CF, Edis AJ, Scholz DA, et al. (1981) Mediastinal parathyroid tumors. *Ann Surg* 193:805–809
5. Clark OH (1988) Mediastinal parathyroid tumors. *Arch Surg* 123:1096–1100
6. Conn JM, Gonclaves MA, Mansour KA, et al. (1991) The mediastinal parathyroid. *Am Surg* 57:62–66
7. Prinz RA, Lonchyna V, Carnaille B, et al. (1994) Thorascopic excision of enlarged mediastinal parathyroid glands. *Surgery* 116:999–1005
8. Smythe WR, Bavaria JE, Hall RA, et al. (1995) Thorascopic removal of mediastinal parathyroid adenoma. *Ann Thorac Surg* 59:236–238
9. Gullstrand P, Olsson G, Olsson M, et al. (1996) Thorascopic parathyroidectomy of an ectopic mediastinal adenoma. *Br J Surg* 83:1757
10. Furrer M, Leutenegger AF, Reudi T (1996) Thorascopic resection of an ectopic giant parathyroid adenoma: indication, technique, and three years follow-up. *Thorac Cardiovasc Surg* 44:208–209
11. Peix JL, Van Box Som P, et al. (1996) Exérèse sous thoracoscopie première d'un adénome parathyroïdien de la fenêtre aortopulmonaire. *Presse Med* 25:494–496
12. Di Bisceglie M, Voltolini L, Paladini P, et al. (1997) Ectopic parathyroid adenoma: two cases treated with video-assisted thorascopic surgery. *Scand Cardiovasc J* 32:51–52
13. Knight R, Ratzner ER, Fenoglio ME, et al. (1997) Thorascopic excision of mediastinal parathyroid adenomas: a report of two cases and review of the literature. *J Am Coll Surg* 185:481–485
14. Inoue S, Tanaka H, Fujita E, et al. (1998) Eosinophilic pleural effusion and peripheral eosinophilia—an uncommon complication of thorascopic parathyroidectomy. *Nephrol Dial Transplant* 13:2929–2931
15. Lesser T, Bartel M (1999) Videothorascopic excision of mediastinal parathyroid adenoma. *Eur J Surg* 165:395–397
16. Oyama T, Imoto H, Yasumoto K, et al. (1999) Mediastinal parathyroid cyst: treatment with thorascopic surgery: a case report. *J UOEH* 21:317–321
17. Medrano C, Hazlerigg SR, Landreneau RJ, et al. (2000) Thorascopic resection of ectopic parathyroid glands. *Ann Thorac Surg* 69:221–223
18. Yoshida T, Nagahama T, Maruyama M, et al. (2001) Thorascopically managed parathyroid adenoma in the upper anterior mediastinum. *Surg Laparosc Endosc Percutan Tech* 11:385–388
19. Ott MC, Malthaner RA, Reid R (2001) Intraoperative radioguided thorascopic removal of ectopic parathyroid adenoma. *Ann Thorac Surg* 72:1758–1760
20. Ishikawa T, Onoda N, Ogawa Y, et al. (2002) Thorascopic excision for ectopic mediastinal parathyroid tumor. *Biomed Pharmacother* 56:34s–36s
21. O'Herrin JK, Weigel T, Wilson M, et al. (2002) Radioguided parathyroidectomy via VATS combined with intraoperative parathyroid hormone testing: the surgical approach of choice for patients with mediastinal parathyroid adenomas? *J Bone Miner Res* 17:1368–1371
22. Cupisti K, Dotzenrath C, Simon D, et al. (2002) Therapy of suspected intrathoracic parathyroid adenoma: experience using open transthoracic approach and video-assisted thorascopic surgery. *Langenbecks Arch Surg* 386:488–493
23. Kumar A, Kumar S, Aggarwal S, et al. (2002) Thorascopy: the preferred method for excision of mediastinal parathyroids. *Surg Laparosc Endosc Percutan Tech* 12:295–300
24. Onoda N, Ishikawa T, Yamada N, et al. (2002) Radioisotope-navigated video-assisted thorascopic operation for ectopic mediastinal parathyroid. *Surgery* 132:17–19
25. Amar L, Guignat L, Tissier F, et al. (2004) Video-assisted thorascopic surgery as first-line treatment for mediastinal parathyroid adenomas: strategic value of imaging. *Eur J Endocrinol* 150:141–147
26. Profanter C, Schmid T, Prommegger R, et al. (2004) Robot-assisted mediastinal parathyroidectomy. *Surg Endosc* 18:868–870
27. Quiros RM, Warren W, Prinz RA (2004) Excision of a mediastinal parathyroid gland with the use of video-assisted thorascopy, intraoperative ^{99m}Tc-sestamibi scanning, and intraoperative monitoring of intact parathyroid hormone. *Endocr Pract* 10:45–48
28. Kitami A, Suzuki T, Usuda R, et al. (2004) Diagnostic and therapeutic thorascopy for mediastinal disease. *Ann Thorac Cardiovasc Surg* 10:14–18
29. Takashima S, Nakano H, Minamoto K, et al. (2005) A thorascopically resected case of mediastinal parathyroid cyst. *Acta Med Okayama* 59:165–170
30. Liu RC, Hill ME, Ryan JA Jr (2005) One-gland exploration for mediastinal parathyroid adenomas: cervical and thorascopic approaches. *Am J Surg* 189:601–605
31. Nwariaku FE, Snyder WH, Burkey SH, et al. (2005) Inframammary parathyroid glands in patients with primary hyperparathyroidism: alternatives to sternotomy. *World J Surg* 28:491–494
32. Karpinski S, Sardi A. Thorascopic resection of a mediastinal intrathymic parathyroid adenoma. *Am Surg* 71:1070–1072
33. Weigel TL, Murphy J, Kabbani L, et al. (2005) Radioguided thorascopic mediastinal parathyroidectomy with intraoperative parathyroid hormone testing. *Ann Thorac Surg* 80:1262–1265
34. Taguchi M, Endo S, Hasegawa T, et al. (2006) Thorascopic findings of a small posterior mediastinal parathyroid adenoma. *Asia Cardiovasc Thorac Ann* 14:86–87
35. Sakumar MS, Komanapalli CB, Cohen JJ. (2006) Minimally invasive management of the mediastinal parathyroid adenoma. *Laryngoscope* 116:482–487
36. Soler R, Bargiela A, Cordido F, et al. (1996) MRI of mediastinal parathyroid cystic adenoma causing hyperparathyroidism. *J Comput Assist Tomogr* 20:166–168
37. Schlinkert RT, Whitaker MD, Argueta R (1991). Resection of selected mediastinal parathyroid adenomas through an anterior mediastinotomy. *Mayo Clin Proc* 66:1110–1113
38. Kao CL, Chou FF, Chang JP (2003) Minimal invasive surgery for resection of parathyroid tumor in the aortopulmonary window. *J Cardiovasc Surg* 44:139–140
39. Wei JP, Gadacz TR, Weisner LF, et al. (1995) The subxiphoid laparoscopic approach for resection of mediastinal parathyroid adenoma after successful localization with TC-99m-sestamibi radionuclide scan. *Surg Laparosc Endosc* 5:402–406
40. Doherty GM, Doppman JL, Miller DL, et al. (1992) Results of multidisciplinary strategy for management of mediastinal parathyroid adenoma as a cause of persistent primary hyperparathyroidism. *Ann Surg* 215:101–106