Chapter 12
Parathyroid

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Mediastinal Parathyroid Glands

Mediastinal parathyroid glands are the result of abnormal migration of the parathyroids during embryogenesis. The parathyroid glands develop from the dorsal wing of the third and fourth pharyngeal pouches [1]. The superior parathyroids derive from the fourth pharyngeal pouch, while the inferior develop from the third one. The ventral wing of the third pharyngeal pouch gives rise to the thymus, which descends to its final position in the mediastinum. The inferior parathyroid glands follow the descending route of the thymus; this explains their ectopic location into the mediastinum [1, 2]. Due to their more extensive migration, inferior parathyroids are more often ectopic than the superior ones.

The prevalence of ectopic parathyroid glands is reported to range from 6.3 to 16% in surgical series [3–7], but a rate of 28–42% is reported in autopsy series [8, 9]. Ectopic parathyroids have been reported in up to 45% of patients with persistent/recurrent primary hyperparathyroidism [7].

About 60–80% of the ectopic mediastinal parathyroid can be found in the superior mediastinum within the thymus or at the origin of the great vessels. The remaining mediastinal parathyroids are located in the middle and posterior mediastinum in variable percentages [10].

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A supernumerary or fifth parathyroid gland is reported in 2.5–22% of the ectopic mediastinal parathyroid gland. Supernumerary glands are usually located in the upper anterior mediastinum within the thymus or perithymic fat [6, 7, 10].

Mediastinal parathyroid glands become of concern when hyperparathyroidism (primary or secondary) occurs. Parathyroid adenomas are the most common cause of primary hyperparathyroidism, accounting for about 85% of cases. They are usually solitary, but a double adenoma can be found in 2–4% of cases. Multiglandular hyperplasia is found in 15% to 20% of cases [2, 11]. Parathyroid carcinoma accounts for about 1% of the case. Rare cases of parathyroid carcinoma in mediastinal parathyroid glands have been described; there are a few reports on giant parathyroid carcinomas mimicking substernal goiter [12].

The actual prevalence of mediastinal parathyroid adenoma (MPA) is unknown but has been reported to range from 6 to 30% [13, 14]. The ectopic mediastinal parathyroid gland is the most common cause for unsuccessful operation for either primary or secondary hyperparathyroidism by experienced surgeon [15–17].

The clinical manifestation of primary hyperparathyroidism from MPA has been reported to be more severe than in eutopic parathyroid adenomas. Patients with MPA are more likely to present with higher calcium levels and more severe bone impairment. This may be due either to the prolonged, persistent hypercalcemia or the often delayed localisation of the mediastinal parathyroid adenomas [4].

Preoperative Localisation

Preoperative localization is essential for a successful mediastinal exploration for parathyroid adenomas. Although a variety of preoperative imaging techniques are available, the optimal preoperative localization study for MPA has not yet been determined.

Technetium-99m (Tc-99m) sestamibi scintigraphy has proven to be the single best imaging modality for preoperative localisation of parathyroid adenomas, with a reported sensitivity of 80–90%. For mediastinal parathyroid adenoma, the Tc-99m sestamibi scan sensitivity and specificity are reported to be lower than for the cervical parathyroid adenomas. Tc-99m sestamibi single-photon emission computed tomography (SPECT) is reported to be superior to planar imaging and in combination with computed tomography (SPECT/CT) can improve both sensitivity and specificity compared to planar scan [18, 19].

Computed tomography (CT) and magnetic resonance imaging (MRI) is useful to identify the mediastinal parathyroid tumour and provide relevant information about its anatomical location and relationship with the other structures. Four-dimensional CT is frequently employed in the preoperative workup for localisation of ectopic parathyroid adenomas [20].

The latest preoperative imaging techniques including dual-energy CT and positron emission tomography (PET) MRI have been reported to be useful in

detecting parathyroid adenomas in cases of failure of conventional imaging [21]. Simultaneous PET-MRI is a new hybrid technique of imaging that allows exact fusion of molecular and anatomical imaging providing excellent soft-tissue analysis [22].

Surgical Approaches

Most of the MPAs can be excised through a cervical approach, by removing the anterior mediastinal fat and the thymus either during the first exploration or in the setting of remedial operations [10]. Only 1–2% of ectopic MPAs require a thoracic approach to be resected [15].

For MPAs that cannot be removed through a cervical approach, a variety of thoracic approaches can be employed including open surgery techniques (sternotomy, thoracotomy) and minimally invasive techniques as thoracoscopy (including robotic-assisted), mediastinotomy, and mediastinoscopy [10]. The selection of the appropriate surgical approach depends on the location of the ectopic parathyroid tumour and is critical for successful mediastinal parathyroid tumour identification and excision.

The sternotomy was the preferred approach for surgical excision in the past. This approach allows an excellent operative view and an accurate tumour identification. In the majority of the cases, it is not necessary to perform a total sternotomy as a partial sternotomy is adequate to provide good access to the anterior mediastinum [23]. These surgical approaches have been reported to be associated with significant complications including phrenic and recurrent laryngeal nerve injuries, pleural effusion, innominate vein laceration, wound infections, mediastinitis, and death in up to 12–29% of cases [10, 24, 25].

Recently the minimally invasive approaches have gained popularity, and thoracoscopic surgery has replaced conventional sternotomy or thoracotomy for resection of deep ectopic MPAs. These minimally invasive surgical techniques have been reported to be feasible and safe with a low rate of complications even in the setting of reoperative procedures [26, 27]. Accurate preoperative localisation is necessary to establish the appropriate surgical approach. Some authors have suggested the level of the aortic arch as a landmark for guiding the proper surgical approach. Based on their experience, they assumed that MPAs located in the superior mediastinum above the level of the aortic arch could be removed successfully through a transcervical approach, while for those found below the aortic arch in the middle or posterior mediastinum, a transthoracic procedure should be employed [14]. Lastly, the robotic approach has recently been described for mediastinal ectopic parathyroid glands [28, 29]. Only a few series have been reported in the literature, describing this technique as a promising surgical approach for mediastinal parathyroid adenomas, in selected cases [29]. Intraoperative PTH monitoring is used to confirm parathyroid adenoma resection and cure of hyperparathyroidism. A PTH level decline of >50% and into the normal range 10 min after adenoma excision is used as a predictor of cure [30].

References

1. Mohebati A, Shaha AR. Anatomy of thyroid and parathyroid glands and neurovascular relations. Clin Anat. 2012;25(1):19–31.
2. Fancy T, Gallagher D III, Hornig JD. Surgical anatomy of the thyroid and parathyroid glands. Otolaryngol Clin N Am. 2010;43(2):221–7.
3. Phitayakorn R, McHenry CR. Incidence and location of ectopic abnormal parathyroid glands. Am J Surg. 2006;191(3):418–23.
4. Mendoza V, et al. Characteristics of ectopic parathyroid glands in 145 cases of primary hyperparathyroidism. Endocr Pract. 2010;16(6):977–81.
5. Hamidi S, et al. Primary hyperparathyroidism: a review of 177 cases. Med Sci Monit. 2006;12(2):26.
6. Summers GW. Parathyroid update: a review of 220 cases. Ear Nose Throat J. 1996;75(7): 434–9.
7. Noussios G, Anagnostis P, Natsis K. Ectopic parathyroid glands and their anatomical, clinical and surgical implications. Exp Clin Endocrinol Diabetes. 2012;120(10):604–10.
8. Nanka O, et al. [Surgical-anatomical study as a part of operative treatment of primary hyperparathyroidism]. Rozhl Chir. 2006;85(12): 618–23.
9. Hojaij F, et al. Parathyroid gland anatomical distribution and relation to anthropometric and demographic parameters: a cadaveric study. Anat Sci Int. 2011;86(4):204–12.
10. Kim AW, Detterbeck FC. Surgical approach to mediastinal parathyroid glands. In: Oertli D, Udelsman R, editors. Surgery of the thyroid and parathyroid glands. Berlin: Springer; 2012. p. 495–504.
11. Kaplan EL, Yashiro T, Salti G. Primary hyperparathyroidism in the 1990s. Choice of surgical procedures for this disease. Ann Surg. 1992;215(4):300–17.
12. Chiofalo MG, et al. Huge parathyroid carcinoma: clinical considerations and literature review. World J Surg Oncol. 2005;3:39.
13. Hu J, Ngiam KY, Parameswaran R. Mediastinal parathyroid adenomas and their surgical implications. Ann R Coll Surg Engl. 2015;97(4):259–61.
14. Iihara M, et al. Thoracoscopic removal of mediastinal parathyroid lesions: selection of surgical approach and pitfalls of preoperative and intraoperative localization. World J Surg. 2012;36(6):1327–34.
15. Wang C, Gaz RD, Moncure AC. Mediastinal parathyroid exploration: a clinical and pathologic study of 47 cases. World J Surg. 1986;10(4):687–95.
16. Taghavi Kojidi H, et al. Unusual ectopic parathyroid adenoma: a case report. Acta Med Iran. 2016;54(8):547–50.
17. Okada M, et al. Location frequency of missed parathyroid glands after parathyroidectomy in patients with persistent or recurrent secondary hyperparathyroidism. World J Surg. 2016;40(3):595–9.
18. Lavely WC, et al. Comparison of SPECT/CT, SPECT, and planar imaging with single- and dual-phase (99m)Tc-sestamibi parathyroid scintigraphy. J Nucl Med. 2007;48(7):1084–9.
19. Moka D, et al. Technetium 99m-MIBI-SPECT: a highly sensitive diagnostic tool for localization of parathyroid adenomas. Surgery. 2000;128(1):29–35.
20. Roy M, et al. Incidence and localization of ectopic parathyroid adenomas in previously unexplored patients. World J Surg. 2013;37(1):102–6.
21. Gimm O, et al. Dual-energy computed tomography localizes ectopic parathyroid adenoma. J Clin Endocrinol Metabol. 2010;95(7):3092–3.
22. Purz S, et al. Visualization of ectopic parathyroid adenomas. N Engl J Med. 2013;369(21): 2067–9.
23. Gold JS, Donovan PI, Udelsman R. Partial median sternotomy: an attractive approach to mediastinal parathyroid disease. World J Surg. 2006;30(7):1234–9.
24. Russell CF, et al. Mediastinal parathyroid tumors: experience with 38 tumors requiring mediastinotomy for removal. Ann Surg. 1981;193(6):805–9.

25. Conn JM, et al. The mediastinal parathyroid. Am Surg. 1991;57(1):62–6.
26. Randone B, et al. Thoracoscopic removal of mediastinal parathyroid glands: a critical appraisal of an emerging technique. Ann Surg. 2010;251(4):717–21.
27. Alesina PF, et al. Thoracoscopic removal of mediastinal hyperfunctioning parathyroid glands: personal experience and review of the literature. World J Surg. 2008;32(2):224–31.
28. Ismail M, et al. Resection of ectopic mediastinal parathyroid glands with the da Vinci robotic system. Br J Surg. 2010;97(3):337–43.
29. Brunaud L, et al. Endoscopic and robotic parathyroidectomy in patients with primary hyperparathyroidism. Gland Surg. 2016;5(3):352–60.
30. Bobanga ID, McHenry CR. Is intraoperative parathyroid hormone monitoring necessary for primary hyperparathyroidism with concordant preoperative imaging? Am J Surg. 2017;213(3):484–8.