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Case Report

Microwave ablation of ectopic mediastinal parathyroid: A case report☆,☆☆

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ABSTRACT

Secondary hyperparathyroidism is a common and serious complication of long-term hemodialysis in patients with chronic renal failure. Ectopic parathyroid is caused by migration defects during early development and contamination of parathyroid tissue during parathyroidectomy, which can lead to difficulty in identifying and treating due to the abnormal location of the proliferating parathyroid. This report describes a 41-year-old male patient with chronic renal failure who developed symptomatic hyperparathyroidism after 6 years of regular hemodialysis, with chest CT and parathyroid 99Tcm-MIBI examination showing hyperplasia of ectopic parathyroidism in the upper mediastinum. Subsequently, ultrasound-guided microwave ablation through suprasternal fossa was performed on the patient. After 1 year of postoperative follow-up, the patient's clinical symptoms were significantly improved, and the parathyroid hormone, blood calcium, and blood phosphorus were all controlled to an ideal level. Based on the successful treatment of this case, we believe that ultrasound-guided microwave ablation is an effective alternative for ectopic parathyroid hyperplasia, especially for patients who have difficulty tolerating conventional surgery.

Introduction

Secondary hyperparathyroidism (SHPT) is a prevalent and severe complication frequently observed in patients with chronic renal failure (CRF) undergoing long-term hemodialysis [1]. This condition arises from the excessive secretion of parathyroid hormone (PTH) due to parathyroid hyperplasia, which results in abnormal calcium and phosphorus metabolism. Consequently, patients may experience symptoms such as bone pain, bone deformities, skin itching, and insomnia, as well as cardiovascular calcification. These complications significantly diminish the quality of life for individuals with chronic kidney disease (CKD) [2,3]. Ectopic parathyroid is caused by migration defects during embryonic development or parathyroid tissue implantation during parathyroidectomy. The incidence of ectopic parathyroid is 14% and 16% in patients with primary HPT and SHPT, respectively [4–6]. Pharma-

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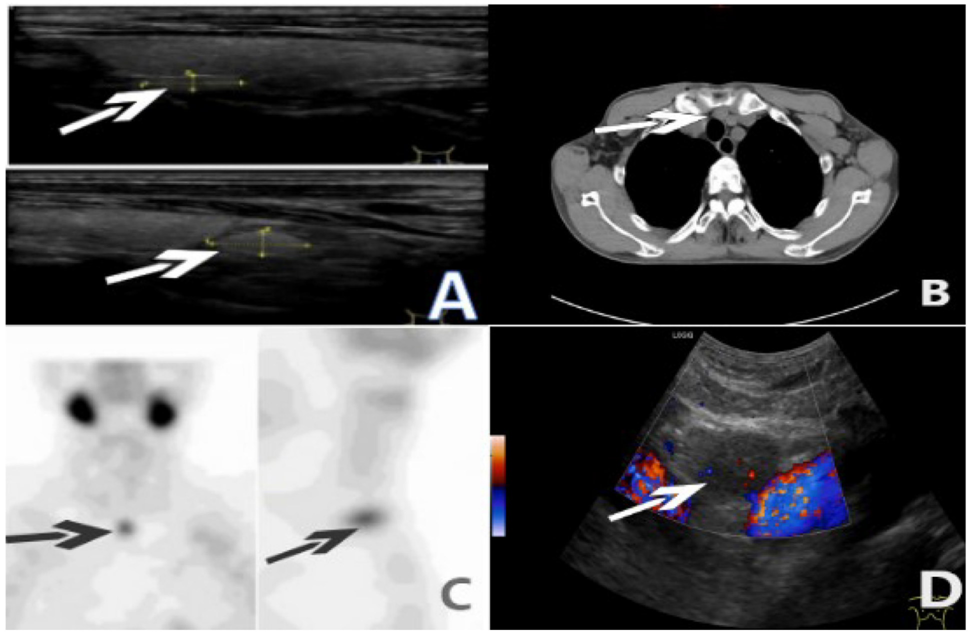

Fig. 1 – Imaging findings of ectopic parathyroid hyperplasia in the upper mediastinum. Ultrasound images of 2 of the patient's normal parathyroid glands (A). Chest CT showed nodules of ectopic hyperplasia in the superior mediastinum (B). Nodule with radioactivity in late phase of MIBI scan (C). Color Doppler ultrasound showed nodules of ectopic hyperplasia adjacent to large vessels (D).

cological interventions serve as the primary treatment for hyperparathyroidism (HPT); however, long-term usage may lead to drug tolerance and prove ineffective for patients with severe HPT [7–10]. At present, parathyroidectomy is employed as a treatment option for some of these patients. Nonetheless, due to the difficulty in locating and diagnosing ectopic SHPT, and the high risk of surgery, the treatment of this condition remains a challenge.

Traditionally, mediastinotomy or thoracoscopy has been the primary methods used when ectopic SHPT is located in the mediastinum [11–14]. However, many dialysis patients with severe cardiopulmonary dysfunction are unable to tolerate the trauma induced by such surgeries. With the advent of minimally invasive surgical techniques permeating all areas of medical treatment, traditional surgery is no longer the sole option. Image-guided ablation techniques, including radiofrequency ablation (RFA), microwave ablation (MWA), laser, percutaneous ethanol injection, and high intensity focused ultrasound, have been widely applied to neck tumors such as thyroid nodules and metastatic lymph nodes, demonstrating significant clinical efficacy [15–18]. This case study reported an instance of SHPT where superior mediastinal ectopic resection of the parathyroid was achieved using microwave ablation.

Case presentation

The patient was a 41-year-old man diagnosed with chronic glomerulonephritis and hypertension 10 years ago, without receiving standard treatment. He was diagnosed with CRF (uremic stage) 6 years ago and underwent regular hemodialysis 3 times a week for 6 years. Two years ago, he experienced symptoms such as bone pain and itching in all 4 limbs, accompanied by limited limb movement. At that time, his parathyroid hormone level was measured at 1520 pg/mL, and the oral treatment with cinacalcet and paricalcitol showed poor results. Surgical treatment was considered during this hospitalization, but the surgeon did not recommend it due to the patient's poor cardiopulmonary function, high assessed surgical risk, and inability to tolerate general anesthesia and surgical trauma. Taking into account the aforementioned reasons, the patient opted for ultrasound-guided microwave ablation therapy.

Upon admission, the patient's serum parathyroid hormone level was found to be 1573 pg/ml, with calcium at 2.67 mmol/L and phosphorus at 2.45 mmol/L. Color ultrasound examination showed that 2 parathyroid tissues were detected in the position of normal parathyroid glands (Fig. 1A). These tissues measured approximately $8 \times 4 \times 6$ mm and $7 \times 4 \times 6$ mm respectively, with no significant increase in volume. The echo was consistent with that of normal parathyroid glands, and there were no abnormal ultrasonic manifestations such as echo reduction or liquefaction. A chest CT scan showed inflammation in the lower lungs, minor bilateral pleural effusion, slight pericardial effusion, calcification of the coronary artery and aortic wall, multiple uneven bone densities, and soft tissue nodules between the innominate artery of the upper mediastinum and the left common carotid artery (Fig. 1B). Given that the parathyroid glands shown by color ultrasound were of normal size and echo, and only 2 parathyroid glands were found, we considered the possibility of ectopic parathyroid hyperplasia. This was in light of their clinical

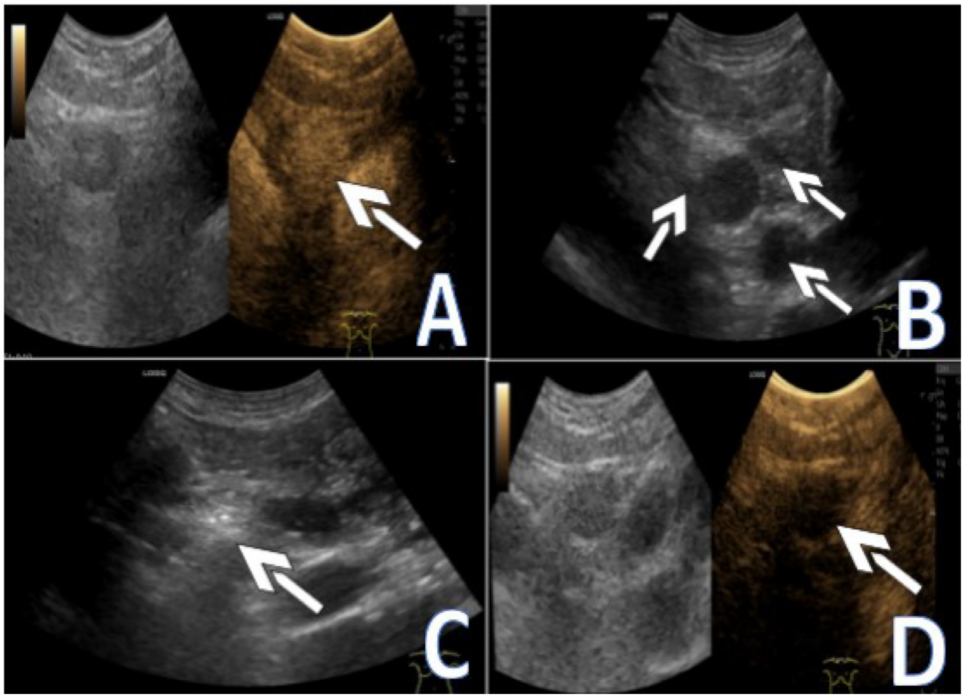

Fig. 2 – Microwave ablation of secondary hyperparathyroidism nodules in the upper mediastinum. Prior to ablation, the superior mediastinal tubercle was uniformly enhanced by contrast-enhanced ultrasound (A). A fluid isolation zone was injected around the nodule (B). Hyperechoic gas was covered when the nodule was completely ablated (C). Postablation contrast-enhanced ultrasound showed no perfusion of contrast agent (D).

manifestations, high blood PTH, high blood calcium, and high blood phosphorus levels. Consequently, a parathyroid 99Tcm-MIBI examination was performed. The examination revealed soft tissue nodules and nuclide concentration in the upper mediastinum, suggesting secondary ectopic parathyroid hyperplasia (Fig. 1C). There was no nuclide concentration in the normal parathyroid area. Color Doppler ultrasound indicated that the left ventricular systolic function was reduced. A pulmonary function examination revealed restrictive pulmonary ventilation dysfunction. Before proceeding with ablation, we conducted a multidisciplinary discussion. Given that the hyperplasia of the parathyroid gland was located in the superior mediastinum, in a special position adjacent to a major artery (Fig. 1D), there was a risk of puncture and major artery leading to massive hemorrhage. Patients and their families were informed of the risks of ablation treatment, and informed consent was signed.

After completing the relevant examinations, the patient underwent ectopic parathyroid hyperplasia microwave ablation under ultrasound guidance. The patient's shoulders were elevated and the neck was tilted back. Before the surgery, hemostatic drugs were administered preventively, and 1 unit of Agkistrodon acutus venom prothrombin activator was injected intramuscularly. The ectopic parathyroid glands were examined using contrast-enhanced ultrasound before the operation (Fig. 2A). The optimal puncture point was determined using ultrasound, and local infiltrative anesthesia was administered after diluting 2% lidocaine and 0.9% sodium chloride in a 1:1 ratio. Under ultrasound guidance, 4°C normal saline was injected at multiple points to create a liquid isolation belt (Fig. 2B). This liquid isolation belt formed a ring around the ectopic parathyroid hyperplasia nodules, providing protection to the surrounding major arteries, skin, and other tissues. The ultrasound-guided microwave ablation needle was used to puncture the target, starting at a low power of 10W. After confirming the position of the needle tip and maintaining a safe distance, the power was increased to 30W to continue the ablation therapy. A moving target point ablation method was employed, and ablation was stopped when the nodule was completely covered by high-echo gas (Fig. 2C). Postoperation, contrast-enhanced ultrasound was performed again to confirm the absence of contrast agent perfusion in the nodules (Fig. 2D), indicating the completion of nodule ablation. The total ablation time was 4 minutes and 58 seconds.

After the ablation procedure, the ablation area was treated with 4°C ice packs for 20 minutes to prevent any residual heat from burning the skin. The patient had no pain, hoarseness, cough or other discomfort after the operation. Serum parathyroid hormone levels decreased to 69 pg/mL within 2 hours after the procedure. A 24-hour postablation ultrasound examination showed no blood perfusion or peripheral bleeding in the ectopic hyperplastic parathyroid gland, and the patient did not experience complications such as hypocalcemia, fever, or hoarseness (The normal reference value ranges for each index in our laboratory are as follows: Ca 2.11-2.52 mmol/L; P 0.85-1.51 mmol/L; PTH 12-65pg/ml). After discharge, the patient underwent regular follow-up examinations for 1 year after the ablation. PTH, blood calcium, blood phosphorus, and other

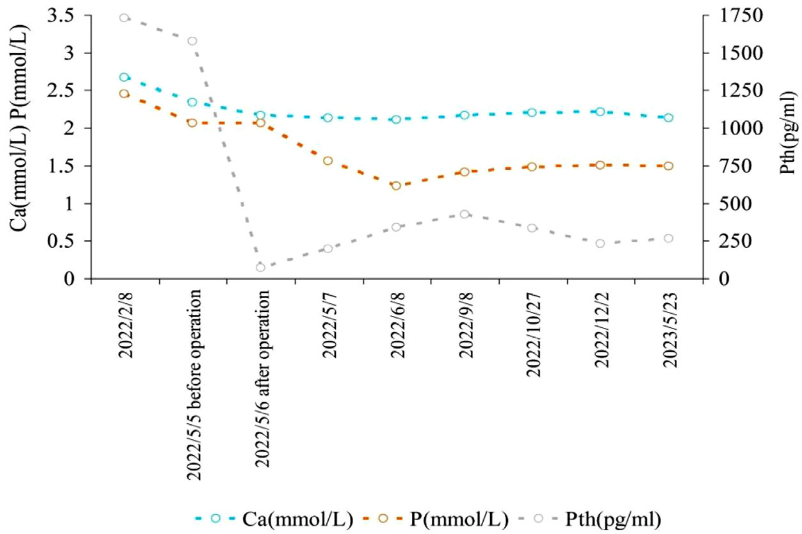

Fig. 3 – Reference value of clinical detection before and after microwave ablation of parathyroid gland: Ca (2.11-2.52 mmol/L); P (0.85-1.51 mmol/L); parathyroid hormone (PTH) (12-65pg/ml).

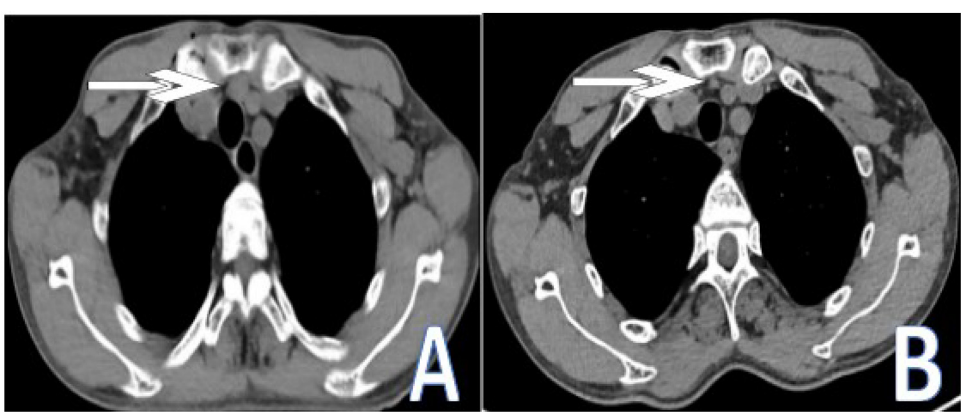

Fig. 4 – Comparison of size changes of parathyroid nodules before and after ablation on chest CT of ectopic hyperplasia. The size of the preablation nodules was about 17 x 12 x 14 mm (A). The size of the nodules after ablation was about 6 x 4 x 6 mm (B).

related indicators were reviewed, and all indicators showed a significant reduction (Fig. 3). The patient's clinical symptoms improved significantly, with the disappearance of bone pain and a significant reduction in insomnia and skin itching symptoms. A CT scan conducted 1 year after the ablation showed a significant reduction in the volume of the ectopic parathyroid nodules, measuring approximately 6 × 4 × 6 mm, with a postablation volume reduction rate of 94.9% (Fig. 4).

Discussion

The parathyroid glands originate from the pharyngeal endoderm during embryonic development. However, the upper and lower parathyroid glands have different origins and migrate different distances, resulting in variations in the number and location of the glands. A meta-analysis of 7005 patients who underwent parathyroid surgery found that 15.9% of them had anatomical variations [19]. In a study by Roy et al., ectopic SHPT was primarily found in the thymus (38%), followed by retroesophageal (31%) and intrathyroid (18%) locations [20–21]. SHPT is characterized by disturbances in calcium and phosphorus metabolism, increased secretion of serum parathyroid hormone, and hyperparathyroidism. It is crucial to control calcium, phosphorus, and parathyroid hormone levels in patients with SHPT.

Long-term drug therapy can lead to drug resistance or treatment ineffectiveness. Severe SHPT patients may require parathyroidectomy, but some patients with cardiopulmonary dysfunction may not tolerate surgery, and incomplete removal may result in secondary surgery and a high recurrence rate of 30% within 1 year [22]. Ectopic SHPT, due to its special location near vital organs or blood vessels, further increases surgical risk. Therefore, a new treatment method is urgently needed for patients who are ineffective with drug therapy and cannot tolerate surgery. In recent years, the development of ultrasound-guided ablation therapy has provided a new possibility for the treatment of SHPT. Studies have reported that radiofrequency ablation can achieve a tumor inactivation rate of over 90% for tumors ≤5.0 cm in size [23–25]. There is no significant difference in terms of local efficacy and long-term survival rate between microwave ablation and radiofrequency ablation [26–27]. Xu et al. [28] demonstrated that radiofrequency ablation effectively controlled iPTH and calcium levels in 2 patients with SHPT.

Ultrasound-guided microwave ablation was successfully performed on this patient, and the patient was regularly followed up for 12 months. The outcome of the ablation was satisfactory. Prior to the ablation therapy, we conducted precise localization to accurately identify the location of the ectopic hyperplastic parathyroid. Studies have shown that approximately 70% of surgical failures are attributed to the inability to accurately locate the patient's ectopic parathyroid glands [29]. During parathyroid ultrasound examinations, if there are no evident signs of hyperplasia in the size and shape of the parathyroid glands in their usual positions, but the patient exhibits elevated PTH levels, abnormal blood calcium and phosphorus levels, and clinical symptoms, we consider the possibility of ectopic parathyroid glands. Therefore, we performed thyroid radionuclide scans and CT examinations, ultimately identifying the ectopic hyperplastic parathyroid glands. Combined with the location shown by CT, ultrasound and contrast-enhanced ultrasound were performed again to confirm the location, and a safe needle entry path for ultrasound-guided ablation was observed.

During the operation, we strictly followed the guidelines, and using fluid isolation bands and moving target ablation techniques to avoid peripheral vascular and nerve damage as well as skin heat damage. After regular follow-up, PTH of the patient was significantly decreased. The KDIGO guidelines recommend that for patients with kidney disease, PTH should be maintained within 2-9 times the upper limit of the standard [30]. In this case, after the ablation, the patient's PTH value was significantly lower than 9 times the upper limit of the standard. At the same time, the patient's blood calcium and blood phosphorus levels were all within the normal range.

One year after ablation, a CT reexamination revealed a significant decrease in the volume of the parathyroid gland with ectopic hyperplasia. This finding confirms that microwave ablation can effectively inactivate hyperplastic parathyroid cells through thermal damage, achieving a therapeutic effect comparable to surgical resection. Additionally, the patient experienced significant relief of clinical symptoms and a substantial improvement in quality of life. Percutaneous ablation at the mediastinal location carries certain risks, including bleeding, puncturing of large blood vessels or the heart, nerve damage, and pneumothorax [31]. However, in this case, the patient did not experience any complications. This can be attributed not only to the technical proficiency of the operator but also to the specific location of the ablation lesion, the ability of ultrasound to identify a safe injection path, and the real-time ultrasound monitoring during the ablation procedure.

Conclusion

In summary, ultrasound-guided microwave ablation offers a potential alternative for the treatment of ectopic parathyroid hyperplasia in CKD patients who cannot undergo surgery, especially those with severe hyperthyroidism. While it is still an emerging technology, further research is needed to evaluate its efficacy and safety in larger clinical samples. However, microwave ablation can provide therapeutic effects similar to surgical resection with minimal trauma, simple operation, and broad indications. It may be considered as an ideal alternative surgery for patients who cannot tolerate or refuse surgical treatment due to poor cardiopulmonary function.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

Patient consent

Written informed consent was obtained from the individual for the publication of any potentially identifiable images or data included in this article.

REFERENCES

[1] Tajbakhsh R, Joshaghani HR, Bayzayi F, Haddad M, Qorbani M. Association between pruritus and serum concentrations of parathormone, calcium and phosphorus in hemodialysis patients. Saudi J Kidney Dis Transpl 2013;24(4):702–6.
[2] Naves-Díaz M, Passlick-Deetjen J, Guinsburg A, Marelli C, Fernández-Martín JL, Rodríguez-Puyol D, et al. Calcium, phosphorus, PTH and death rates in a large sample of dialysis patients from Latin America. The CORES Study. Nephrol Dial Transplant 2011;26(6):1938–47.
[3] Peng C, Zhang Z, Liu J, Chen H, Tu X, Hu R, et al. Efficacy and safety of ultrasound-guided radiofrequency ablation of hyperplastic parathyroid gland for secondary hyperparathyroidism associated with chronic kidney disease. Head Neck. 2017;39(3):564–71.
[4] Tublin ME, Yim JH, Carty SE. Recurrent hyperparathyroidism secondary to parathyromatosis: clinical and imaging findings. J Ultrasound Med 2007;26(6):847–51.
[5] 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.
[6] Lu HI, Chou FF, SY Chi, Huang SC. Thoracoscopic removal of hypertrophic mediastinal parathyroid glands in recurrent secondary hyperparathyroidism. World J Surg 2015;39(2):400–9.
[7] Cannata-Andía JB, Fernández-Martín JL, Zoccali C, London GM, Locatelli F, Ketteler M, et al. Current management of secondary hyperparathyroidism: a multicenter observational study (COSMOS). J Nephrol 2008;21(3):290–8.

[8] He Q, Zhuang D, Zheng L, Fan Z, Zhou P, Zhu J, et al. Total parathyroidectomy with trace amounts of parathyroid tissue autotransplantation as the treatment of choice for secondary hyperparathyroidism: a single-center experience. BMC Surg 2014;14:26.
[9] Steinl GK, Kuo JH. Surgical management of secondary hyperparathyroidism. Kidney Int Rep 2020;6(2):254–64.
[10] Kidney Disease: improving global outcomes (KDIGO) CKD-MBD Work Group. KDIGO clinical practice guideline for the diagnosis, evaluation, prevention, and treatment of Chronic Kidney Disease-mineral and Bone Disorder (CKD-MBD). Kidney Int Suppl 2009(113):S1–130.
[11] Lu HI, Chou FF, SY Chi, Huang SC. Thoracoscopic removal of hypertrophic mediastinal parathyroid glands in recurrent secondary hyperparathyroidism. World J Surg 2015;39(2):400–9.
[12] Alesina PF, Moka D, Mahlstedt J, Walz MK. Thoracoscopic removal of mediastinal hyperfunctioning parathyroid glands: personal experience and review of the literature. World J Surg 2008;32(2):224–31.
[13] Ravipati NB, McLemore EC, Schlinkert RT, Argueta R. Anterior mediastinotomy for parathyroidectomy. Am J Surg 2008;195(6):799–802.
[14] Randone B, Costi R, Scatton O, Fulla Y, Bertagna X, Soubrane O, et al. Thoracoscopic removal of mediastinal parathyroid glands: a critical appraisal of an emerging technique. Ann Surg 2010;251(4):717–21.
[15] Dietrich CF, Müller T, Bojunga J, Dong Y, Mauri G, Radzina M, et al. Statement and recommendations on interventional ultrasound as a thyroid diagnostic and treatment procedure. Ultrasound Med Biol 2018;44(1):14–36.
[16] Mainini AP, Monaco C, Pescatori LC, De Angelis C, Sardanelli F, Sconfienza LM, et al. Image-guided thermal ablation of benign thyroid nodules. J Ultrasound 2016;20(1):11–22.
[17] Mauri G, Nicosia L, Della Vigna P, Varano GM, Maiettini D, Bonomo G, et al. Percutaneous laser ablation for benign and malignant thyroid diseases. Ultrasonography 2019;38(1):25–36.
[18] Mauri G, Cova L, Ierace T, Baroli A, Di Mauro E, Pacella CM, et al. Treatment of metastatic lymph nodes in the neck from papillary thyroid carcinoma with percutaneous laser ablation. Cardiovasc Intervent Radiol 2016;39(7):1023–1030.
[19] Taterra D, Wong LM, Vikse J, Sanna B, Pękala P, Walocha J, et al. The prevalence and anatomy of parathyroid glands: a meta-analysis with implications for parathyroid surgery. Langenbecks Arch Surg 2019;404(1):63–70.
[20] Roy M, Mazeh H, Chen H, Sippel RS. Incidence and localization of ectopic parathyroid adenomas in previously unexplored patients. World J Surg 2013;37(1):102–6.
[21] Said SM, Cassivi SD, Allen MS, Deschamps C, Nichols FC 3rd, Shen KR, et al. Minimally invasive resection for mediastinal ectopic parathyroid glands. Ann Thorac Surg 2013;96(4):1229–33.
[22] Steinl GK, Kuo JH. Surgical management of secondary hyperparathyroidism. Kidney Int Rep 2020;6(2):254–64.
[23] Lin SM, Lin CJ, Lin CC, Hsu CW, Chen YC. Radiofrequency ablation improves prognosis compared with ethanol injection for hepatocellular carcinoma < or =4 cm. Gastroenterology 2004;127(6):1714–23.
[24] Shiina S, Teratani T, Obi S, Sato S, Tateishi R, Fujishima T, et al. A randomized controlled trial of radiofrequency ablation with ethanol injection for small hepatocellular carcinoma. Gastroenterology 2005;129(1):122–30.
[25] Lencioni RA, Allgaier HP, Cioni D, Olschewski M, Deibert P, Crocetti L, et al. Small hepatocellular carcinoma in cirrhosis: randomized comparison of radio-frequency thermal ablation versus percutaneous ethanol injection. Radiology 2003;228(1):235–40.
[26] Shibata T, Iimuro Y, Yamamoto Y, Maetani Y, Ametani F, Itoh K, et al. Small hepatocellular carcinoma: comparison of radio-frequency ablation and percutaneous microwave coagulation therapy. Radiology 2002;223(2):331–7.
[27] Lu MD, Xu HX, Xie XY, Yin XY, Chen JW, Kuang M, et al. Percutaneous microwave and radiofrequency ablation for hepatocellular carcinoma: a retrospective comparative study. J Gastroenterol 2005;40(11):1054–60.
[28] Zhuo L, Peng LL, Zhang YM, Xu ZH, Zou GM, Wang X, et al. US-guided microwave ablation of hyperplastic parathyroid glands: safety and efficacy in patients with end-stage renal disease—a pilot study. Radiology 2017;282(2):576–84.
[29] Uludag M, Isgor A, Yetkin G, Atay M, Kebudi A, Akgun I. Supernumerary ectopic parathyroid glands. Persistent hyperparathyroidism due to mediastinal parathyroid adenoma localized by preoperative single photon emission computed tomography and intraoperative gamma probe application. Hormones (Athens) 2009;8(2):144–9.
[30] Ketteler M, Block GA, Evenepoel P, Fukagawa M, Herzog CA, McCann L, et al. Executive summary of the 2017 KDIGO Chronic Kidney Disease-Mineral and Bone Disorder (CKD-MBD) Guideline Update: what's changed and why it matters. Kidney Int 2017;92(1):26–36.
[31] Holzheimer RG, Mannick JA. Surgical treatment: evidence-based and problem-oriented. Munich: Zuckschwerdt; 2001.