Methods for Identification of Parathyroid Glands During Total Thyroidectomy

Mohamed Abdelmohsen Alnemr, Ahmad Ramadan Lehni, Mohammed Kamal Mobashir

Abstract

Background: Parathyroid failure is the most common symptom after thyroidectomy. To prevent it, a gland was preserved in situ or an ischemic one was auto transplanted. This mini review explored different methods for identification of parathyroid glands during total thyroidectomy.

Aim of this study: to explore different methods for identification of parathyroid glands during total thyroidectomy.

Conclusions: Systematic identification of as many parathyroid glands as possible during total thyroidectomy is not necessary for functional parathyroid preservation.

Key Words: Thyroidectomy · Parathyroid identification · Hypocalcemia · Hypoparathyroidism.

DOI Number: 10.14704/NQ.2022.20.12.NQ77120 **NeuroQuantology 2022; 20(11): 1410-1412**

Introduction

Total thyroidectomy is a common surgical procedure and is often the treatment of choice for a number of benign and malignant conditions. However, despite being a relatively safe procedure in experienced hands, hypoparathyroidism remains one of the most common complications (1).

Routine identification:

The term "routine identification" refers to a strategy where the surgeon would try his or her best to identify each and every PG in its orthotopic or non-orthotopic position. This has traditionally been the approach accepted by many surgeons. However, the pitfall with this strategy is that not all PGs could be found in their orthotopic or usual positions. For example, some superior PGs are located at the superior pole of the posterior thyroid gland near the cricothyroid junction and some inferior PGs may be located far away from the neck in the thymus and mediastinum. Therefore, even with the best intention, it may not be always possible to identify each and every PG at the time of total thyroidectomy. The other pitfall is that this strategy may lead to inadvertent damage to the nearby blood supply and therefore, may devitalize PGs leading to hypoparathyroidism. Also, this strategy may unnecessarily prolong the operation (2).

Corresponding author: Ahmad Ramadan Lehni **E-mail:** ahmadlehni82@gmail.com

Affiliations:
Otorhinolaryngology, Head and Neck Surgery Department, Faculty of Medicine- Zagazig University, Zagazig, Egypt

Relevant conflicts of interest/financial disclosures:
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Methylene blue:

Methylene blue is a hetero-cyclic aromatic chemical compound which has been widely used in sentinel lymph node biopsies (3).

For prevention of hypoparathyroidism, staining of the parathyroid glands is not a new technique but was first described by Klopper and Moe in 1966 (4).

Methylene blue (MB) was administered at a calculated dose of 5 mg/kg body weight in 500 ml of 5% glucose, intravenous administration of methylene blue resulted in staining of both normal and abnormal parathyroid glands. The administration of high-dose MB can be associated with serious adverse events such as toxic metabolic encephalopathy and can lead to blue staining of the complete surgical field due to leakage of dye into the tissue when the operation takes a long time (5).

High-dose MB (7.5 mg/kg) has many disadvantages. The operative field may be discoloured by blue dye; the staining may not be visualized through overlying tissue or fascia; there may be significant discolouration of the patient's skin and urine and patients may suffer severe allergic reaction to the dye, At these high doses, MB also exerts neurotoxic effects, especially when used in conjunction with serotonin reuptake inhibitors (SSRIs), adding significant morbidity to an otherwise relatively safe procedure (6).

Another safer method is methylene blue spraying technique during total thyroidectomy allowed to safely identify RLN and parathyroid glands. most surgeons aim to preserve the nerves and parathyroid glands from potential risks. The sooner the nerve and parathyroid glands are identified, the lower the surgeon level of stress. The technique for safe thyroid surgery is based on visualization of the parathyroid glands, recurrent laryngeal nerve, and thyroid arteries. This new technique ensures not only identification of parathyroid glands within the minutes, but also identification of the recurrent laryngeal nerve and thyroid arteries (7).

Intraoperative optical coherence tomography imaging:

Optical coherence tomography (OCT) is a non-invasive high-resolution imaging technique that permits characterization of microarchitectural features in real time. The technique is capable of distinguishing between parathyroid tissue, thyroid tissue, lymph nodes, and adipose tissue (8).

Optical coherence tomography (OCT) is a high-resolution microscopic imaging modality that combines a broadband, low-coherent light with interferometry to visualize living tissue microstructure, OCT works in a similar manner to ultrasound but uses near-infrared light instead of sound waves to distinguish intrinsic differences in tissue structures. In general, OCT systems can have an axial resolution of approximately 10 μm with a depth penetration up to 2 mm (9).

Current standard to identify parathyroid glands intraoperatively is via frozen sections, there is time delay needed to biopsy, process tissues, embed and stain, and then finally have the slides read by a pathologist, additionally, it is tedious and potentially impossible to also inspect all the surrounding tissues, noninvasive methods include the float and sink method or the use of staining agents, both of which can be inaccurate and cause adverse effects (8).

Importantly, OCT imaging has a limited penetration depth of only 2 mm. It evaluates only the superficial layers of tissues, and in some cases may provide false readings due to tissue samples being surrounded by adipose tissue. This may cause false identification of tissue types is the specific tissue of interest is surrounded by a fat layer. In addition, the resolution of the commercial OCT Imalux system is below that of contemporary research devices, and therefore, improvements in technology development is still needed for better image resolution in the portable commercial system (9).

Near-infrared fluorescence (NIRF):

Is one of several novel technologies that may be useful in early identification and preservation of parathyroid glands during surgery. Fluorophores re-emit light of a higher wavelength when excited by a light source. Some emit light outside of the visible spectrum in the near infra-red region (700–900 nm). NIRF has been used in surgery to aid real-time intraoperative visualization of tissues and differentiate between tissue types including sentinel lymph node mapping (5).

Indocyanine green fluorescent imaging:

Lang et al (10) located and predicted function of PGs with indocyanine green (ICG) fluorescent imaging in both thyroid and parathyroid surgery. ICG is a water-soluble molecule that binds to plasma protein and confined to intravascular compartment. It will emit fluorescent light when being excited by near-infrared light (NIR); thus, the combination of ICG and NIR may provide real-time assessment on tissue perfusion within a focused area reflected by the fluorescent light intensity. ICG fluorescent imaging potentially helps locate PGs and thus prevent inadvertent parathyroidectomy or damaging them.

Moreover, ICG angiography may provide quantitative evaluation of in situ PG perfusion after total thyroidectomy, and could be a good predictor for post-operative hypoparathyroidism. Therefore, ICG fluorescent angiography could potentially be a less invasive option for identifying PGs during thyroidectomy and provide more accurate prediction of parathyroid function (2).

The chance of complications due to intravenous administration of the dye, including neurotoxicity and acute dye-induced phototoxicity, pain at infusion site and nausea is a major drawback of this technique (11).

This method which is considered very expensive and requires a special dye which is expensive and a special camera is also expensive, so it is difficult to find in most hospitals (5).

Conclusion

Systematic identification of as many parathyroid glands as possible during total thyroidectomy is not necessary for functional parathyroid preservation.

REFERENCES

1. **Lorente-Poch L, Sancho JJ, Munoz-Nova JL, et al.** Defining the syndromes of parathyroid failure after total thyroidectomy. Gland Surg 2015; 4:82-90.
2. **Chang, Y. K., & Lang, B. H.** To identify or not to identify parathyroid glands during total thyroidectomy. Gland surgery 2017, 6(Suppl 1), S20.
3. **Zolfaghari, P. S., Packer, S., Singer, M., et al.** In vivo killing of Staphylococcus aureus using a light-activated antimicrobial agent. BMC microbiology2009, 9(1), 1-8.
4. **Klopper, P. J., & Moe, R. E.** Demonstration of the parathyroids during surgery in dogs, with preliminary report of results in some clinical cases. Surgery1966, 59(6), 1101-1107.
5. **Tummers, Q. R., Schepers, A., Hamming, J. F., et al.** Intraoperative guidance in parathyroid surgery using near-infrared fluorescence imaging and low-dose Methylene Blue. Surgery 2015, 158(5), 1323-1330.
6. **Patel, H. P., Chadwick, D. R., Harrison, B. J., et al.** Systematic review of intravenous methylene blue in parathyroid surgery. Journal of British Surgery 2012, 99(10), 1345-1351.
7. **Sari, S., Aysan, E., Muslumanoglu, M., et al.** Safe thyroidectomy with intraoperative methylene blue spraying. Thyroid research 2012, 5(1), 1-5.
8. **Sommerey, S., Al Arabi, N., Ladurner, R., et al.** Intraoperative optical coherence tomography imaging to identify parathyroid glands. Surgical endoscopy 2015, 29(9), 2698-2704.
9. **Rubinstein, M., Hu, A. C., Chung, P. S., et al.** Intraoperative use of optical coherence tomography to differentiate normal and diseased thyroid and parathyroid tissues from lymph node and fat. Lasers in medical science 2021, 36(2), 269-278.
10. **Lang BH, Chan DT, Chow FC, et al.** The Association of Discolored Parathyroid Glands and Hypoparathyroidism Following Total Thyroidectomy. World J Surg 2016; 40:1611-7.
11. **Van Den Bos, J., van Kooten, L., Engelen, S. M., et al.** Feasibility of indocyanine green fluorescence imaging for intraoperative identification of parathyroid glands during thyroid surgery. Head & Neck 2019, 41(2), 340-348.