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Review Article

Life Structures and Embryology of the Parathyroid Organ

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Abstract

Anatomical dissections to locate the aberrant glands would be guided by the embryology of the parathyroid glands, according to experienced parathyroid surgeons. In situations where the glands are not in their "normal" placements, this becomes more crucial. The embryology, which is so closely related to the final anatomic placement of the glands, must be understood by surgeons. Patients frequently experience unsuccessful surgical investigations as a result of the parathyroid glands being in ectopic places that were not recognised. Knowledge of the embryology of the parathyroid can fill in the gaps and point the surgeon in the right direction. The platform for parathyroid surgery will be established by this article's exploration of variances in anatomic position, relationship to important structures like the recurrent laryngeal nerve, the number of glands, and even gland size and morphology.

Keywords: Anatomical dissections, Embryology, Parathyroid surgeons, Laryngeal nerve

INTRODUCTION

The efficient surgical management of parathyroid disease situations requires a thorough grasp of the embryology of the parathyroid glands. Although a thorough understanding of embryology is crucial for all elements of head and neck surgery, it might be argued that the surgical therapy of hyperparathyroidism is the only area in the head and neck where this knowledge is more crucial **(Carthew RW et al., 2009).** The embryology of the parathyroid glands will guide experienced parathyroid surgeons during surgical dissections to pinpoint the aberrant glands, they understand. When the glands are not in their "natural" placements, this is immediately apparent. Given that embryology is closely related to the eventual anatomical placement of the glands, surgeons must be well-versed in it. The main cause of unsuccessful surgical explorations is frequently a failure to recognise the parathyroid glands that are situated in the ectopic places **(Borges F et al., 2015).** The surgeons can be helped by a solid understanding of parathyroid embryology by pointing them in the direction of potential ectopic locations. To give the framework for parathyroid surgery, we want to investigate the variations in anatomic position, relation to important structures like the recurrent laryngeal nerve, the number of glands, and even gland size and morphology. This knowledge is helpful before surgery as well, during the preoperative evaluation stage when localization tests are carried out to direct a directed exploration or a more thorough 4-gland exploration.

Common contemplations

At weeks 5–6 of pregnancy, the endoderm epithelial cells of the pharyngeal pouches give rise to the parathyroid glands, which Sandstrom originally identified. They start migrating to their final location in the lower neck along with the thyroid and thymus in the seventh week of pregnancy, both caudally and medially. If a typical migration occurs, the inferior glands would cross over the superior glands and settle on the lower pole of the thyroid gland's dorsal surface, or a little more caudal in the thyrothymic ligament or the thymus **(Sinha SK 2010).** It is possible to differentiate the parathyroid glands from the brighter, less distinguishable yellow fat that the parathyroids are often closely connected with by their flat, bean- or leaf-like form and yellow-tan, caramel, or mahogany hue. These are ovoid glands that range in size from 3 to 8 mm and weigh 35 to 40 mg. They can be seen as distinct bodies gliding in the more amorphous fat that surrounds them as this fat is carefully handled. In addition to adipose tissue and fibro vascular stroma, they are made up of chief and oxyphilic cells.

In most cases, both the upper and lower parathyroids exhibit mirror-image symmetry. The search for the equivalent right gland can then be aided by locating the left gland. Its symmetry has been described in detail in an anatomic series that found 70% symmetry for the inferior glands and 80% symmetry when comparing the right and left superior parathyroid glands. The inferior thyroid artery, which is the main circulatory supply to both the upper and lower parathyroid glands in 76%-86% of instances, largely supports the glands **(Obbard DJ et al., 2009).** The majority of descriptions of the parathyroid's anatomy are based on surgical evidence. As a result, there may be limitations in the literature, such as anatomical descriptions that are dependent on the disease process, restricted site exposure and search efforts, and a natural preference for surgical goals over data gathering.

There are typically 4 parathyroid glands. Nonetheless, there could be 5 glands or more, or in extremely rare cases, less than 4. Extensive autopsy series have shed light on the glands' numerical variance. It has been reported that supernumerary gland incidence is 13%. The bulk of the extra parathyroid glands was quite small less than 5 mg and situated close to the normal glands. In the same series, 84% of individuals had 4 glands, while only 3% had just 3 glands **(Li C et al., 2019).** Another big series with almost 400 patients found that 0.5% of the patients had 6 glands, 25% had 5 glands, 87% had 4 glands, and 6.1% had 3 glands. When undertaking parathyroid investigations, surgeons must take this numerical variance into account. The thymus and the mediastinum are two additional places where the supernumerary glands can be found.

Predominant parathyroid organs

The superior parathyroid glands are connected to the lateral thyroid anlage, also known as the C-cell complex, and they develop from the fourth branchial pouch. They are also known to as parathyroid IV because of their origin. Because to their shared lateral thyroid origin, they have also been classified as thyroid parathyroids. They cling to the caudally moving thyroid glands posterior surface when they lose their connection to the pharyngeal wall **(Williams M et al., 2004).** As a result, the posterolateral side of each thyroid lobe roughly follows the location of the superior parathyroid glands. Due to its shorter embryologic migration path, the superior parathyroid has a less varied final adult position than the inferior parathyroid. The superior parathyroid gland's distribution area is shown in.

Around 1 cm above the point where the RLN and inferior thyroid artery converge, the superior parathyroid gland is normally found at the level of the laryngeal cricothyroid articulation. It frequently rests on the thyroid capsule here and is strongly associated to the posterolateral side of the superior thyroid pole. It might be slightly hidden by the RLN, inferior thyroid artery, or Zuckerkandl tubercle or it might be located farther caudally. They may even be found living much more inferior, behind the lower thyroid pole **(Brantl S 2002).** The superior glands may very rarely-less than 1% of the time-is found above the upper thyroid pole. These might be located fairly deep in the neck, possibly towards the retrolarynx or the retroesophagus. According to the aforementioned autopsy investigation, 80 percent of the superior glands were found within a 2 cm-diameter circle on the posterior face of the thyroid gland, about 1 cm above the place where the RLN and inferior thyroid artery crossed.

In the neck, the superior parathyroid is situated at a plane that is deep to the plane of the RLN. In patients with primary hyperparathyroidism having parathyroidectomy, an interesting recent study looked at the anatomic closeness of parathyroid tumours to the RLN. Intraoperative nerve monitoring was employed in this prospective study, which included 136 patients with primary hyperparathyroidism **(Agrawal N et al., 2003).** It was used to validate RLN identification and to measure the distance between the RLN and the parathyroid tumour. The results showed that the RLN frequently located within 0.52 cm on average of the parathyroid adenoma. Average distance from the nerve for tumours in the right upper position was 0.25 cm, and 47% of these tumours bordered the nerve. Compared to tumours in other positions, those in the right upper position abutted the RLN the most frequently.

Ectopic anatomic areas of the predominant parathyroid organs

Due to less embryologic migration throughout development, the site of the superior parathyroid glands is more stable, and they are rarely found in ectopic places. The majority of ectopic sites are uncommon and may be the result of lateral or descending failure. The tracheoesophageal groove, posterior mediastinum, retroesophageal positions, and retropharyngeal positions in the carotid sheath or intrathyroidal locations are examples of ectopic placements. In Akerstrom's anatomic autopsy investigation, ectopic superior parathyroid glands were discovered in less than 1% of patients and in less than 2% of subjects above the thyroid gland's upper pole. The posterior neck, retropharyngeal, and retroesophageal regions were among the additional ectopic sites. Intrathyroidal placement is possible very seldom. The superior glands can join the ultimobranchial body as it fuses with the median thyroid, causing an abnormal migration pattern those results in the intrathyroidal location. Acquired ectopic localization can also result from pathologic gland enlargement in addition to ectopic location from embryologic development variability **(Liu S et al., 2020).** Gravity and the dynamic movements of the larynx and pharynx during swallowing might cause enlarged glands to migrate. The superior parathyroid glands are more likely to exhibit this than the inferior glands, which are less likely to do so due to anatomical restrictions that should supposedly prohibit this gravity-induced displacement.

Second rate parathyroid organs

The third branchial pouch gives rise to the inferior parathyroid glands, which migrate together with the thymus anlage. As a result, the inferior parathyroid glands have been given additional names such as parathyroid III (PIII) and thymic parathyroid, which are similar to the names given to the superior parathyroid glands and their embryologic origin. The inferior parathyroid glands and the thymus are produced by the dorsal and ventral wings of the third pharyngeal pouch, respectively. The inferior parathyroid glands separate from the pharyngeal wall and join the thymus as it travels medially and caudally to the mediastinum. This explains why the inferior parathyroid glands are located in a plane ventral to the superior parathyroid glands and why they have a more variable adult position than the superior glands. The dissemination area of PIII glands is illustrated in and contrasted with the dispersal area of PIV, which has a significantly larger area of dispersal **(Chen X et al., 2019).** The inferior parathyroid is frequently situated on the posterolateral aspect of the inferior pole capsule or within 1-2 cm of the inferior pole of the thyroid. It frequently has a close relationship to the thyrothymic horn's thickened fat. Typically, the inferior parathyroid lies superficially to the RLN.

Ectopic anatomic areas of the second rate parathyroid organs

The surgeon aiming for a successful investigation is particularly concerned about the inferior parathyroid glands' increasing unpredictability in position. Anywhere along the extensive area of descent up to the superior border of the pericardium is where the inferior glands can be discovered. When an inferior gland fails to descend with the thymus, it may develop near to the carotid bifurcation and is frequently lodged in an ectopic thymic remnant. According to anatomical research, undescended parathyroid glands can be seen in up to 2% of necks. As the incidence of undescended parathyroid glands has been reported to be less than 1% in original cases that have not undergone surgery in the past and as low as 0.08% in extremely large series of 3,000 individuals, the clinical importance is somewhat less definite **(Clancy S 2008).** When the primitive attachment of the inferior parathyroid glands to the thymus still exists, inferior parathyroid glands may be discovered at the level of the anterior superior mediastinum towards the top pole of the thymic remains. The significance of superior mediastinal examination for inferior glands that cannot be located within the neck is implied by this embryology. The aortopulmonary window is a less frequent but documented mediastinal site of the ectopic parathyroid gland. The uncommon intrathyroidal ectopic placement must also be taken into account. The incidence ranges from 0.7% to 3.6% depending on the series. Even supernumerary glands can be intrathyroidal parathyroidal glands, which can be PIII or PIV. Studies have not confirmed the anticipation that PIV would represent a higher proportion of intrathyroidal parathyroid glands due to incorporation within the thyroid when the ultimobranchial bodies merge with the median thyroid residual. In fact, according to some researchers, inferior parathyroid glands make up the majority of intrathyroidal glands **(Wilson RC et al., 2013).** The incidence of intrathyroidal inclusions of parathyroid tissue coming from the third pharyngeal pouch is comparable to that of thymic tissue inclusions. Some thymic tissue may split into tiny pieces that can occasionally stay entrenched in the thyroid gland.

CONCLUSION

Despite the fact that most parathyroid glands may be found in predictable anatomic locations, understanding embryologic variability is essential for a successful parathyroid surgery. The surgeon who is prepared to examine anatomic areas known to house these glands can easily manage ectopic anatomic localization due to various embryologic migration patterns of the glands, particularly the inferior parathyroid glands.

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CONFLICT OF INTEREST

No conflict of interest declared.

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