

Study of Different Presentation and Varied Diagnostic Modalities of Parathyroid Adenoma and an Emerging Role of 4D-CT Scan

Rajkumar Patel*, Maulik B. Mehta**, Pankaj R. Modi***

Abstract :

A Prospective Study carried out at Civil Hospital and B. J. Medical College, Ahmedabad on varied presentations and efficiency of imaging modalities in Parathyroid adenoma and outcome in its surgical management. 7 cases of parathyroid adenoma were included with 6 in neck and 1 case of an ectopic adenoma which were managed via minimally invasive approach of parathyroidectomy leading to cure of symptoms with no post operative complications. The most common presenting symptom in this patient was related to Renal System (50%). Also the most common symptom complex was related to renal system (71%) and other being related to Pancreatitis and related to Skeletal System. Also the available available imaging modalities were tested for in its anatomical and functional localization leading to judicious recommendation of use of 4D-CT in this disease. Sensitivity of Ultrasound, Tc-Sestamibi Scan and 4D-CT Scan was found to be 86%, 72% and 100% respectively. Also the recommendation of 4D-CT was only during the discordant finding between Biochemical plus SonoGram v/s Sestamibi Scan.

Keywords : 4D-CT, Ectopic Parathyroid Adenoma, Minimally Invasive Parathyroidectomy, Parathyroid Adenoma, Tc99-Sestamibi.

Introduction :

Hyperparathyroidism has its varied presentation from chronic kidney disease, pathological fracture, chronic pancreatitis to asymptomatic neck swelling. Patients are usually referred from orthopaedics department or urology department for hyperparathyroidism and seldom presents with complaint of asymptomatic neck swelling. Primary hyperparathyroidism is most commonly due to Solitary Parathyroid Adenoma (80%), multiple adenomas or hyperplasia (15-20%) and parathyroid carcinoma (<1%) of cases.⁽¹⁾ Pre-operatively localization studies are necessary for "Minimally Invasive" approach including focused unilateral neck exploration to videoscopic approaches. Present study is newer imaging modality, i.e., 4D-CT involving study of perfusion of contrast in hyperfunctioning parathyroid tissue over time.

Aims and Objectives :

To study the presenting symptom and symptom complex in patients with parathyroid adenoma and

comparing various imaging modalities in its functional and spatial diagnosis and also to evaluate the rationale of 4D-CT in today's scenario.

Methodology :

The study is a Prospective Study carried out at Department of General Surgery, B. J. Medical College and Civil Hospital, Ahmedabad from May 2017 to August 2019. Inclusion Criteria: All patients with hyperparathyroidism with serum PTH >300pg/ml and serum Calcium >11.5mg/dl. Exclusion criteria: patients with Secondary and tertiary Hyperparathyroidism

Present study includes 7 patients with 4 female and 3 male patients. Localization of enlarged gland was done with Ultrasonogram of Neck and later by Technitium99-Sestamibi Scan for functional evaluation. Out of 7 cases, Ultrasonogram revealed a focal lesion in 6 cases and Tc99-Sestamibi Scan showed focal increased uptake in 5 cases with no lesion detected in 2 cases. In those 2 cases 4D-CT was done. In one case 4D-T was done for better anatomic delineation of surrounding anatomy. Patients with bone fracture were also investigated further with Vitamin D3 levels and also investigated for detection and confirmation of Osteoporosis. Patients for Minimally Invasive Parathyroidectomy were operated with local neck incision over the swelling and later skin

* 3rd year Resident

** Assistant Professor

*** Associate Professor, Department of General Surgery, B. J. Medical College, Civil Hospital Ahmedabad, Gujarat, India

Correspondence : Dr. Maulik B. Mehta

E-mail : drmehta79@yahoo.com

and platysma were cut. Strap muscles were separated from midline after identifying the two Anterior Jugular Veins and separating them from in between. Plane created between Thyroid capsule and underneath of strap muscles and adenoma tissue was identified as having a orange brown colour. It was excised after separating from surrounding adhesions and safely identifying the Recurrent Laryngeal Nerve and Inferior Thyroid Artery. Adenomatous Tissue was confirmed as the one which sinks when kept in water and no frozen section or intraoperative PTH studies were done. Adequate hemostasis was confirmed and closure was done in layers with vicryl 2/0 absorbable suture and skin with Epimide 3/0. Suture removal was done on Post Operative Day 5. No Drains used. All patients were operated via minimal invasive approach with focussed neck incision and one via minimally invasive thoracoscopy for an ectopic adenoma. The post-operative period was uneventful with none of study participants having reported post-operative Hypocalcaemia (symptomatic), recurrent laryngeal nerve palsy or any other complications. Repeat Serum Parathormone and Serum Calcium were done in immediate postoperative period within 24 hours. No recurrences were reported in any follow up until a period of about maximum 2 years to minimum of 4 months.

Results:

The presenting complaints in patient with adenoma was most common due to Renal Stones or Nephrocalcinosis. As Shown in Figure No.1, Renal Symptoms remained the most common presenting complaint in 50% of patients with Pancreatitis related symptoms like recurrent back pain and vomiting in 30% and with 20% having multiple pathological bone fracture.

50% of patients had renal symptoms as presenting complaints and 30% and 20% had pancreatitis and fracture related complaint as their chief complaint respectively.

Considering the symptom complex, Renal Symptoms were found to be most common amongst the patients i.e., in 5 out of 7 patients i.e., 71% as shown in Figure No. 2.

5 patient had renal symptoms (71%). 3 patients had pancreatitis related symptoms (44%) and 2 patient had Skeletal Symptoms i.e., Bone related like Fracture or bone pain (28%).

The sensitivity of 4D-CT scan was found to be 100% and was able to localize all the 3 of 3 parathyroid adenoma. However Ultrasound Neck was able to locate adenoma in 6 out of 7 patients and was unable to detect in case of an ectopic tissue making its Sensitivity 86%. Sestamibi Scan can locate 5 out of 7 tissue making its sensitivity only 72% as shown in Table No.1.

Sonogram Neck was positive in 6 of 7 cases. Sestamibi Scan was positive in 5 of 7 cases and 4D-CT was positive in all 3 of 3 cases used. Out of 6 parathyroid adenoma in neck, 3 were left inferior (43%), 2 were right inferior (28%) and 1 was left superior (14%). One patient with ectopic Parathyroid adenoma in Superior Mediastinum (14%) as can be correlated from Figure No.3

In Case no.5, the patient had history of multiple long bone fractures with S.PTH of 1163.8 pg/ml. Ultrasound Neck was normal. Sestamibi Scan did not show any focal increase in uptake of radiotracer and was not suggestive of any parathyroid adenoma (as shown in Figure 4). With a strong suspicion of adenoma at any ectopic site, we went for 4D-CT and it showed a 21 x 23 x 25 mm Ectopic Parathyroid Adenoma in anterior and superior mediastinum on right side anterior to Ascending Aorta (as in figure 5).

Sestamibi Scan did not show any focal increase in uptake of Radiotracer at 20 minutes, 2.5 hours or at 4 hours.

A 21 x 23 x 25 mm well defined hypo-dense lesion in anterior and superior mediastinum on right side anterior to Ascending Aorta showing intense enhancement on arterial phase and early washout on venous phase.

The mean Preoperative and Postoperative Serum Parathormone was 1001.8 ng/L and 36.9 ng/L respectively (Figure 6). The mean Preoperative and Postoperative Serum Calcium was 14.1mg/dL and 9.3 mg/dL respectively (Figure 7).

Figure 6 shows the preoperative and post operative levels of serum parathormone in all 7 patients and the average levels. Average Preop level is 1001.8ng/L and average postop level is 36.9ng/L.

Figure 7 shows the preoperative and post operative levels of serum Calcium in all 7 patients and the average levels. Average Preop level is 14.1 mg/dL and average postop level is 9.3mg/dl.

Figure 1: Chief presenting complaint in study of patient with Parathyroid Adenoma

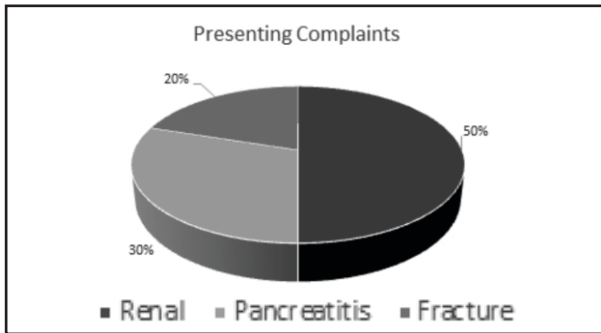


Figure 2: Chart showing the percentage of patient with symptom complex in study

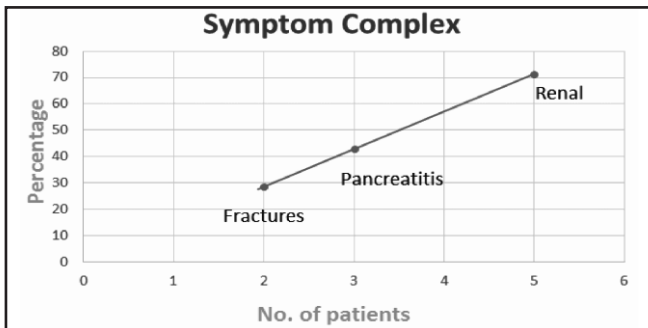


Table 1: Different Imaging modalities used in patients for confirmation and localization

Investigation	Number	Positive (%)	Negative (%)
Sonogram - Neck	7	6 (86%)	1 (14%)
Tc99-Sestmibi Scan	7	5 (72%)	2 (28%)
4D-CT	3	3 (100%)	0 (0%)

Figure 3 : Spatial diagnosis of various Parathyroid Adenoma diagnosed in Study participants

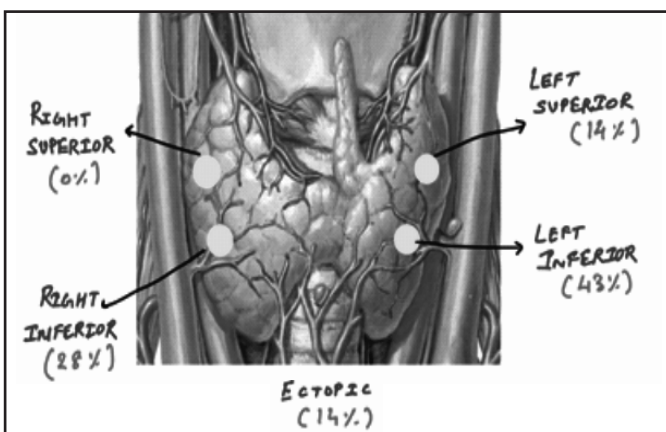


Figure 4: Sestamibi Scan of Patient with Ectopic Parathyroid Adenoma

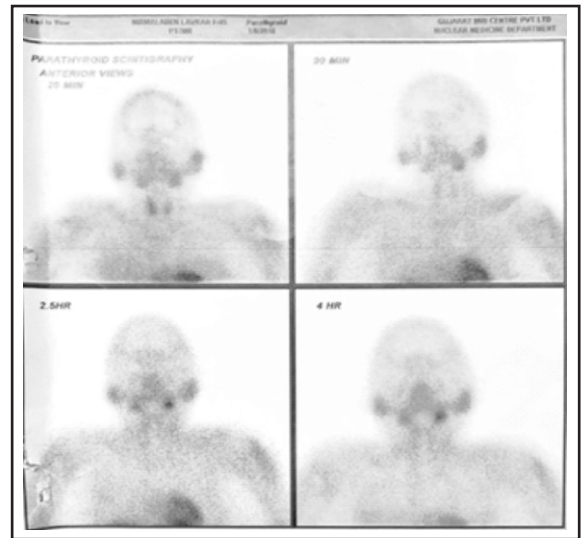


Figure 5 : 4D-CT of patient with Ectopic Parathyroid Adenoma



Figure 6: Levels of Serum Parathormone in Study Patients

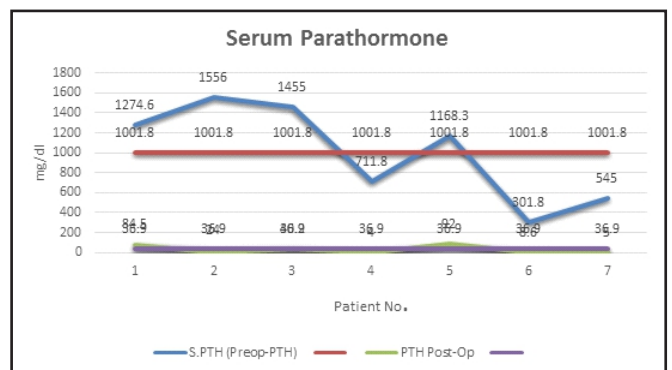


Figure 7: Levels of Serum Calcium in Study Patients

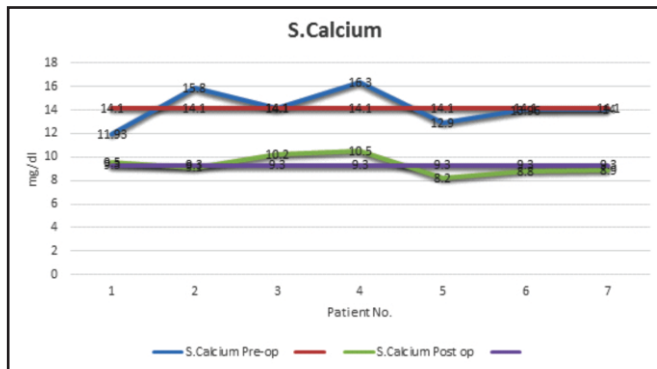
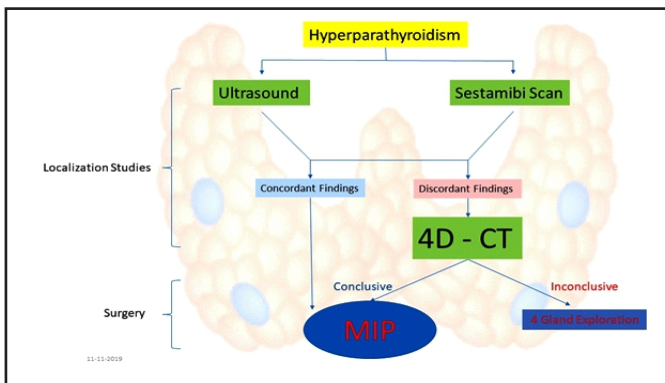


Figure 8 : Rationale of using 4D-CT in case of Parathyroid Adenoma



Discussion :

The term “4D CT” has various interpretations. The original description by Rodgers et al⁽⁷⁾ described the first three “dimensions” as multiplanar CT scan: axial scan with sagittal and coronal reformatted image, while the fourth “dimension” was the change in the perfusion pattern of the adenoma over three phases: noncontrast, arterial, and venous scans. Since that time, different modifications to the original protocol were introduced. This included four phases or scans (a nonenhanced scan and three contrast-enhanced scans), or three or two phases (scans). For this study, we used four scans including noncontrast, arterial, venous, and delayed images. Since that time, we have modified our 4D protocol and use the protocol as described by Hoang et al.⁽⁸⁾ 4D CT has higher sensitivity for localization of parathyroid adenomas compared to sestamibi imaging, given its higher spatial resolution.⁽⁷⁾ This allows for accurate preoperative localization of even small adenomas. In their study, Galvin et al⁽⁹⁾ highlighted the

fact that the smallest lesion detected by scintigraphy was 10 mm versus 4 mm on 4D CT. In addition, the pattern of contrast enhancement of parathyroid adenoma is very characteristic, showing intense enhancement in the arterial phase (peak enhancement between 25 and 60 seconds following contrast injection) with washout of contrast in the delayed phases.⁽⁸⁾ This feature in particular can differentiate parathyroid adenoma from its main mimic, lymph node. Lymph nodes show progressive enhancement over time with peak enhancement at 90 seconds⁽⁸⁾, corresponding to the venous phase in the 4D CT protocol.

The sensitivity of 4D-CT was 89.4% as primary imaging modality, 71.8% prior negative localizing study and 74.9% inconclusive localizing study in one of the case series for Parathyroid Adenoma⁽⁶⁾.

4D CT has higher sensitivity than scintigraphy for single- and multigland disease. Each modality has its own limitations, but missed lesions are more likely to occur with multigland disease for both modalities and in smaller lesions for scintigraphy.⁽¹⁰⁾

Conclusion :

Parathyroid adenoma presents as Recurrent Renal Stones, Recurrent Or Chronic Pancreatitis or with Multiple Pathological Fractures. Hence a sense of suspicion is always required in these patients. Parathyroid adenoma causing primary hyperparathyroidism are usually solitary which makes its functional and spatial diagnosis important for minimally invasive extraction. Most common site is LEFT INFERIOR (50% v/s 43%).⁽³⁾ 4D-CT is particularly indicated for DISCORDANT Biochemical-Sonogram v/s Tc99-Sestamibi Scan and in cases of HIGH DEGREE OF SUSCPICION and also for excellent anatomical delineation at ectopic sites.⁽⁴⁾ Ectopic Parathyroid Adenoma is not an uncommon condition. Its prevalence is about 14% in my study v/s 3.5%.⁽⁵⁾ 4D-CT is a technique which involves TIME as the dimension. It gives both anatomical and functional aspect of parathyroid tissue. Pre, post and delayed images with shows EARLY ENHANCEMENT AND WASHOUT demonstrating the highly metabolic tissue and also differentiates nodes from parathyroid tissue. The CT component gives us an excellent anatomic delineation of lesion. Disadvantage includes higher cost and higher dose of radiation.

Acknowledgement

I would like to thank the Department of Nuclear Medicine, GCRI, Ahmedabad for the Sestamibi Scans and also the Department of Radiodiagnosis, Sterling Hospitals, Ahmedabad for 4D-CT Correspondence.

References:

1. Schwartz Principles of Surgery, Chapter 38, Page No.1665.
2. <https://in.pinterest.com/pin/295126581824603554/>.
3. Schwartz Principles of Surgery, Chapter 38, Page No.1668.
4. Bailey and Love's Short Practice of Surgery, 27E, Ch:51, Page 829.
5. Nilubol N et al. Mediastinal hyperfunctioning Parathyroid incidence, evolving treatment and outcome. Am J Surg; 2007; 194 53-56.
6. Cheung et al, Ann Surg Oncol 2012; 19(2): 577-583.
7. Kutler DI, Moquete R, Kazam E, Kuhel WI. Parathyroid localization with modified 4D-computed tomography and ultrasonography for patients with primary hyperparathyroidism. Laryngoscope 2011;121:1219e24.
8. Hoang JK, Sung WK, Bahl M, Phillips CD. How to perform parathyroid 4D CT: tips and traps for technique and interpretation. Radiology 2014;270:15e24.
9. Galvin L, Oldan JD, Bahl M, Eastwood JD, Sosa JA, Hoang JK. Parathyroid 4D CT and scintigraphy: what factors contribute to missed parathyroid lesions? Otolaryngol Head Neck Surg 2016;154:847e53.
10. Leo Galvin et al; Sage Journals of Otolaryngology volume 154; Issue 5; Page : 847-853 [https:// doi.org/\10.1177/0194599816630711](https://doi.org/10.1177/0194599816630711).