Case-Based Discussion

Presented by : R1 應無諍

Supervised by : VS 吳伯軒

Presentation date : 2025/02/18

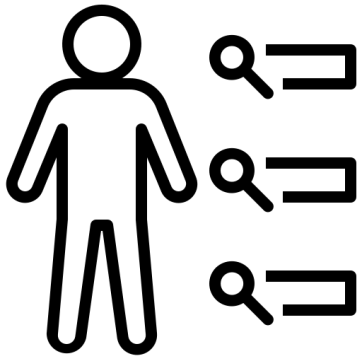
Outline

- Case
  Thyroid papillary carcinoma s/p bilateral total thyroidectomy, complicated with hypoparathyroidism
- Discussion
  Emerging imaging technologies for parathyroid gland identification and vascular assessment in thyroid surgery
- Take home message

Patient profile

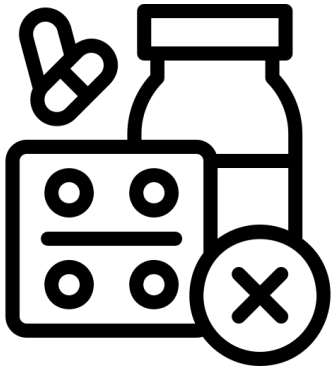
- Name : 蔡 古 O 香
- Chart number : 916238
- Age : 75 y/o
- Gender : Female
- Admission date : 2025/02/03

Past hx, Personal hx, Family hx

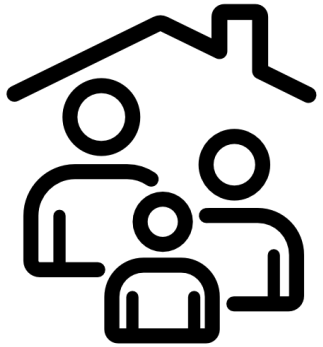


HTN, T2DM, HLP
Left OME s/p myringotomy in 2018
s/p cardiac catheterization 20+ yrs
L-spine s/p spinal fusion

Alcohol: (-)
Betel nuts: (-)
Cigarette: (-)



NKA



Denied family hx

Chief complaint

Left anterior neck mass noted for one month

Present illness

2024/10

- Left anterior neck mass noted for one month
- No hoarseness, odynophagia or dyspnea noted
- LMD: suspect thyroid cancer, referred to our hospital

Present illness

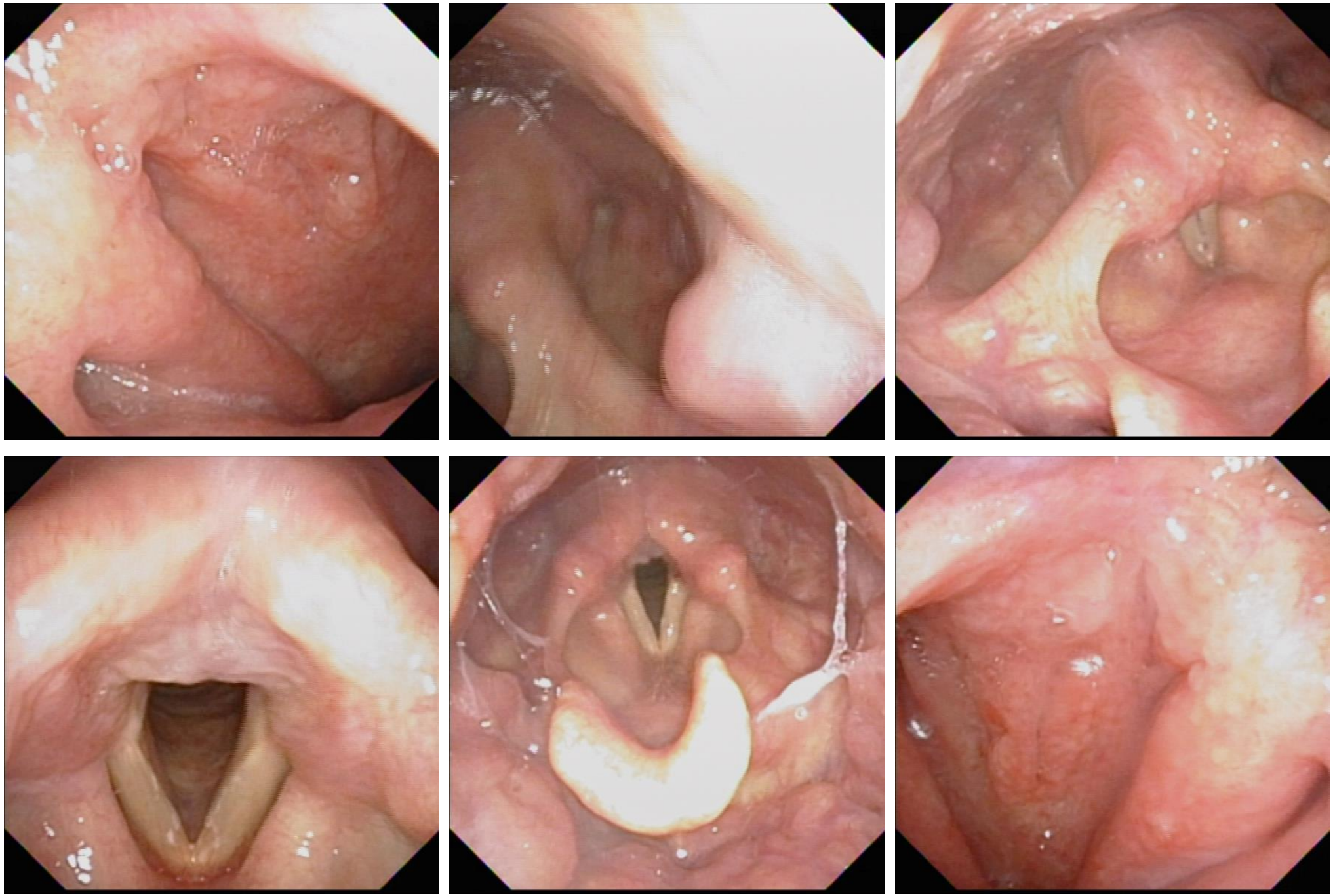
2024/10

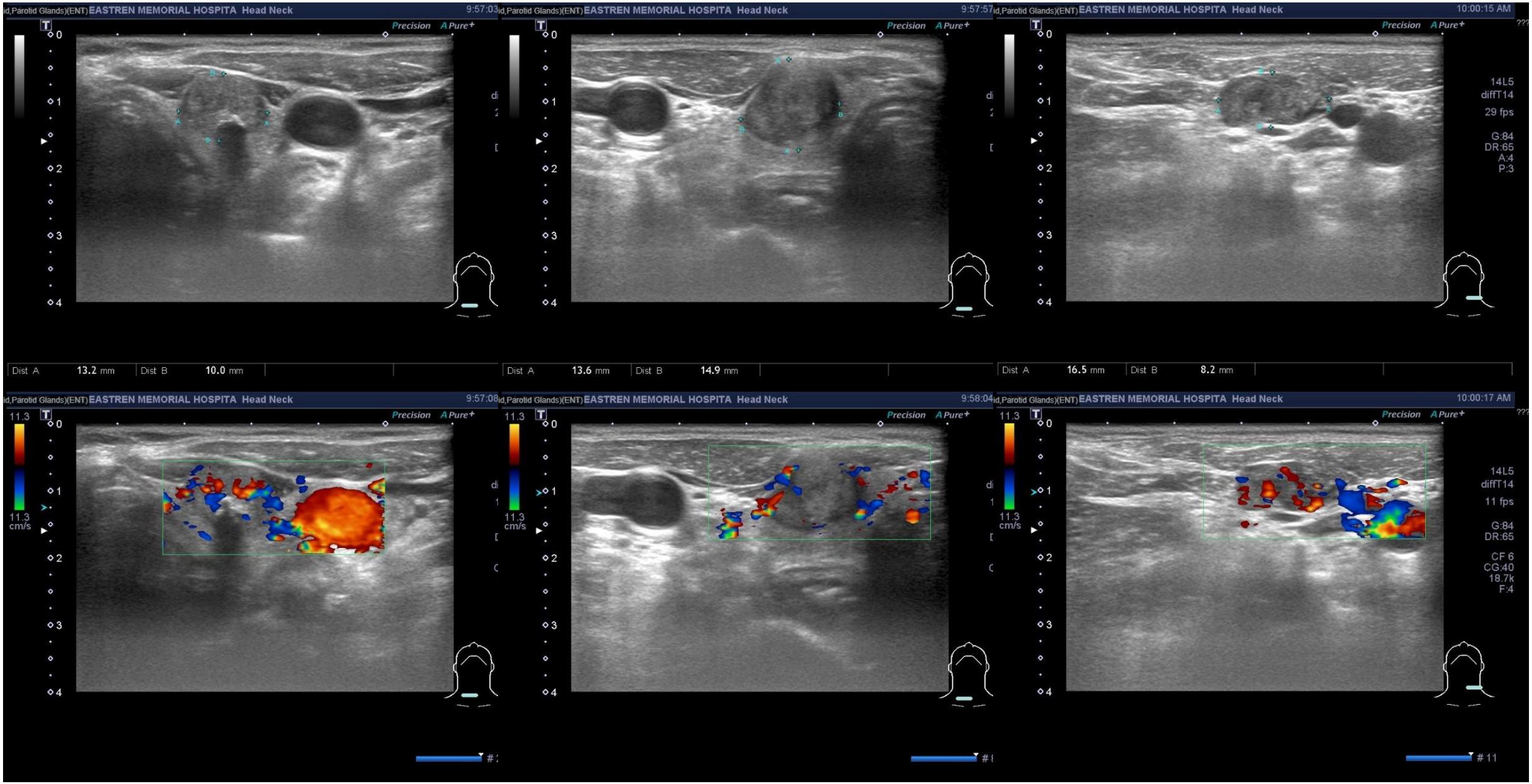
- Left anterior neck mass noted for one month
- No hoarseness, odynophagia or dyspnea noted
- LMD: suspect thyroid cancer, referred to our hospital

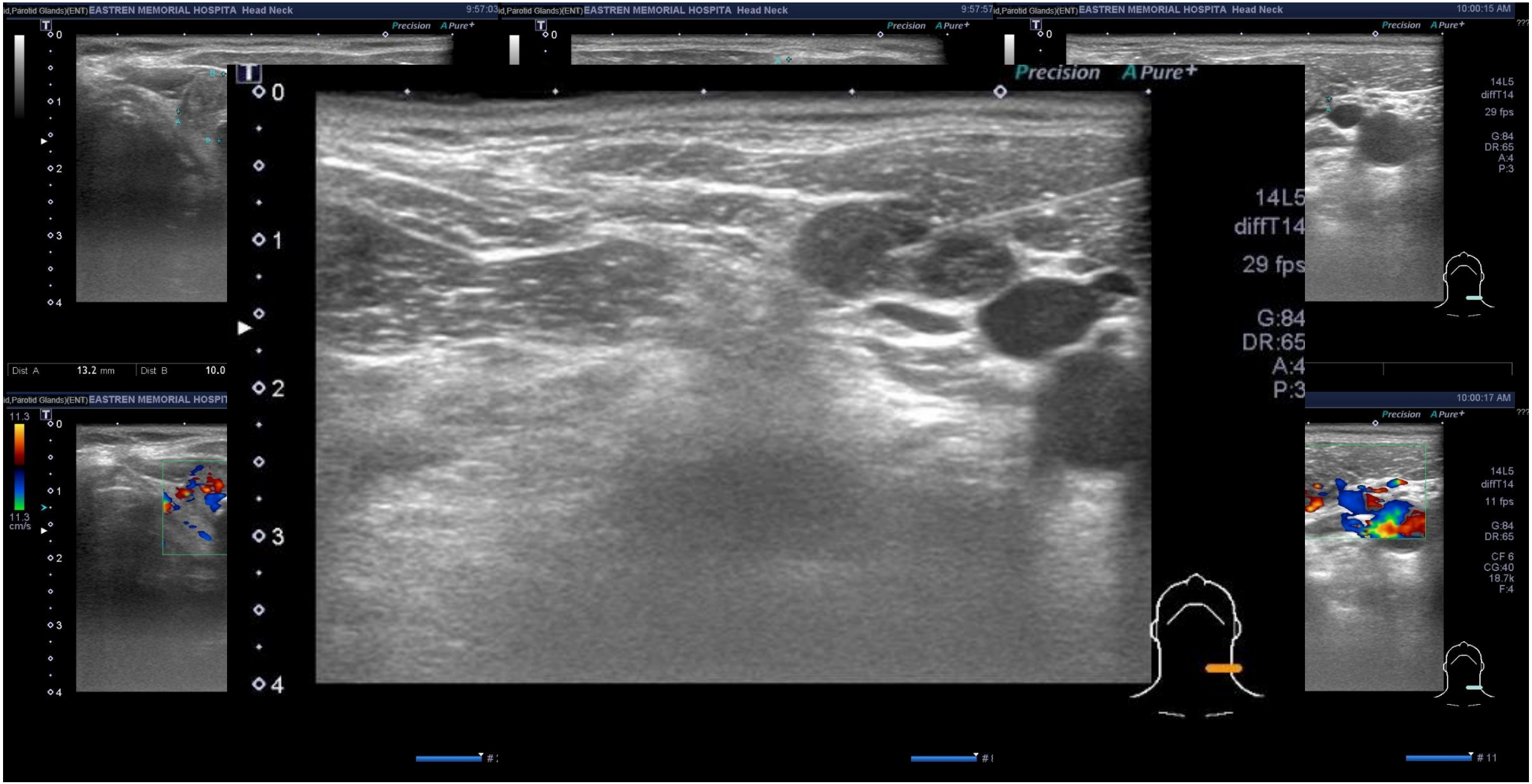
OPD

2024/11/08

- Anterior neck mass around 1.5 cm
- Fiber: NP lymphoid tissue, no obvious mass lesion over hypopharynx or larynx, laryngeal pachydermia, good VF movement
- Check thyroid function and arrange sonography




id,Parotid Glands)(ENT) EASTREN MEMORIAL HOSPITA Head Neck
9:57:03
Precision A Pure+
Dist A 13.2 mm Dist B 10.0 mm
id,Parotid Glands)(ENT) EASTREN MEMORIAL HOSPITA Head Neck
9:57:57
Precision A Pure+
Dist A 13.6 mm Dist B 14.9 mm
id,Parotid Glands)(ENT) EASTREN MEMORIAL HOSPITA Head Neck
10:00:15 AM
Precision A Pure+
14L5
diffT14
29 fps
G:84
DR:65
A:4
P:3
Dist A 16.5 mm Dist B 8.2 mm
id,Parotid Glands)(ENT) EASTREN MEMORIAL HOSPITA Head Neck
9:57:08
11.3
11.3 cm/s
Precision A Pure+
id,Parotid Glands)(ENT) EASTREN MEMORIAL HOSPITA Head Neck
9:58:04
11.3
11.3 cm/s
Precision A Pure+
id,Parotid Glands)(ENT) EASTREN MEMORIAL HOSPITA Head Neck
10:00:17 AM
11.3
11.3 cm/s
Precision A Pure+
14L5
diffT14
11 fps
G:84
DR:65
CF 6
CG:40
18.7k
F:4
11


id,Parotid Glands)(ENT) EASTREN MEMORIAL HOSPITA Head Neck
9:57:03
Precision A Pure+
Dist A 13.2 mm
Dist B 10.0
11.3 cm/s
14L5
diffT14
29 fps
G:84
DR:65
A:4
P:3
10:00:17 AM
11 fps
CF 6
CG:40
18.7k
F:4

Free T4	Blood	1.44	ng/dL
3rd-generation TSH	Blood	1.770	uIU/mL

病理報告

檢驗名稱	Thyroid Aspiration Cytology		
採檢時間	2024-11-15		
簽收時間	2024-11-15 14:52	報告時間	2024-11-18 15:27
報告醫師	黃文志	病理編號	N2024009113
複閱醫師			

檢驗前診斷名稱	Malignant Neoplasm Of Thyroid Gland;Swelling, Mass, Or Lump In Head And Neck;
檢驗後診斷名稱	採檢部位及名稱：left neck LAP, r/o papillary thyroid carcinoma metastatic LN Positive for malignancy. Tumor cells with focal pseudoinclusions and lymphoid cells are seen. Metastatic papillary thyroid carcinoma could be compatible. Please correlate with the clinical feature for management.

Present illness

2024/10

- Left anterior neck mass noted for one month
- No hoarseness, odynophagia or dyspnea noted
- LMD: suspect thyroid cancer, referred to our hospital

OPD

2024/11/08

- Anterior neck mass around 1.5 cm
- Fiber: NP lymphoid tissue, no obvious mass lesion over hypopharynx or larynx, laryngeal pachydermia, good VF movement
- Check thyroid function and arrange sonography

OPD

2024/11/22

- Left papillary thyroid carcinoma with suspected left neck metastasis s/p FNA of left neck level III LAP
- Arrange bil. total thyroidectomy + left neck LN dissection +/- central neck dissection

ADM

2024/11/29

- Admitted for scheduled operation
- Pre-op survey: generally normal

CBC-I	Blood		
HGB	Blood	12.0	g/dL
HCT	Blood	37.6	%
MCV	Blood	97.4	fL
RBC	Blood	3.86	10^6/μL
MCHC	Blood	31.9	g/dL
WBC	Blood	8.25	10^3/μL
WBC DC	Blood		
Platelet	Blood	257	10^3/μL
Neutrophil	Blood	71.5	%
Lymphocyte	Blood	21.2	%
Monocyte	Blood	4.6	%
Eosinophil	Blood	2.1	%
Basophil	Blood	0.6	%
MCH	Blood	31.1	pg
RDW-CV	Blood	13.5	%
PDW	Blood	9.3	fL
MPV	Blood	9.30	fL
Plateletcrit	Blood	0.24	%

PT	Blood		
APTT	Blood		
PT	Blood	10.3	sec
INR	Blood	0.98	
APTT	Blood	24.1	sec

Na	Blood	139	mmol/L
K	Blood	3.8	mmol/L
Ca	Blood	8.9	mg/dL
Creatinine	Blood	0.55	mg/dL
Creatinine & eGFR	Blood		
ALT	Blood	9	U/L
Glucose AC	Blood	179	mg/dL
eGFR(MDRD)	Blood	>60	
Sample Hemolysis	Blood	1+	


L

916238 2024-11-29 13:08:55 蔡古瑞香
75 Year Female

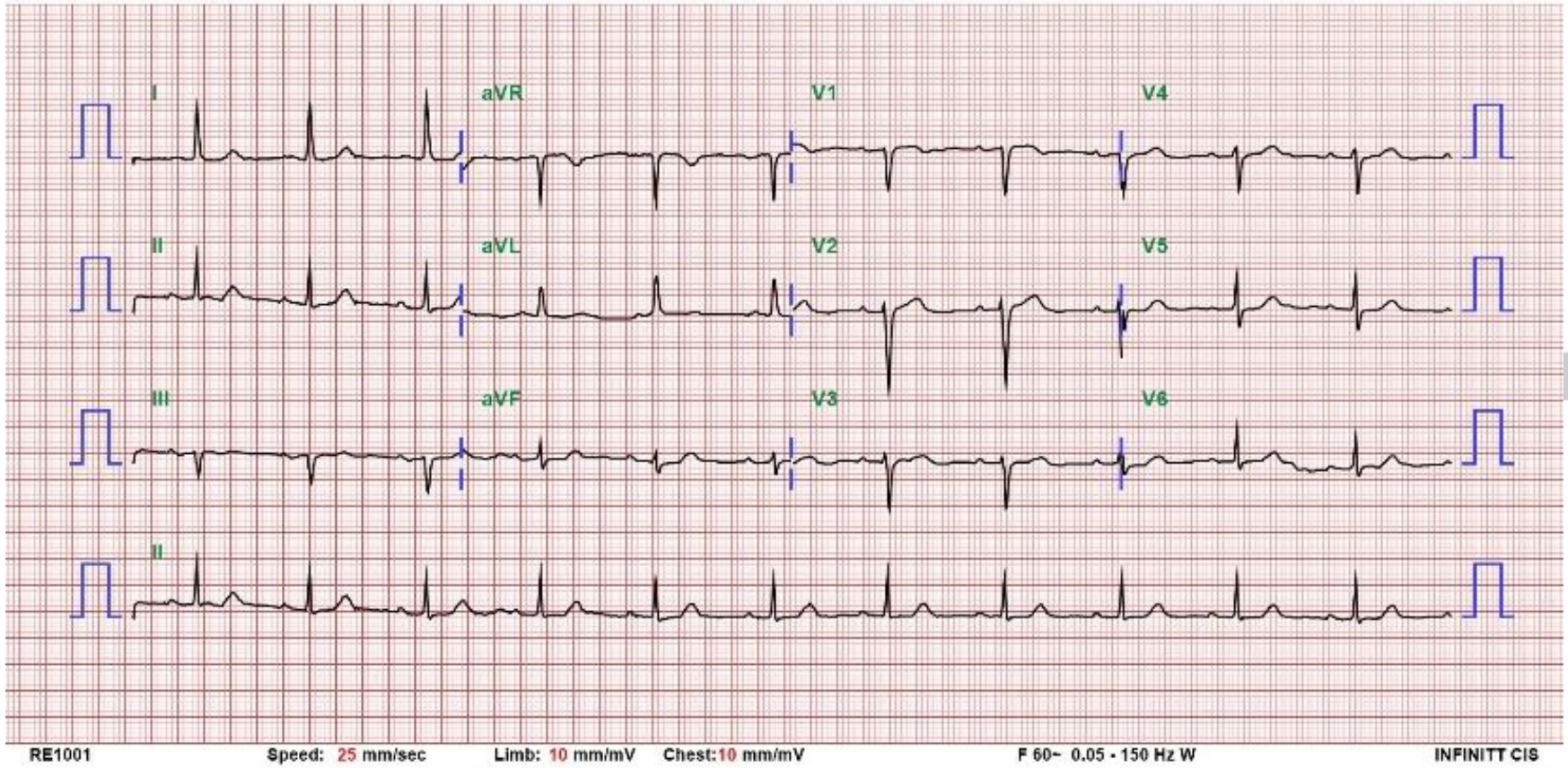
Institution: CV ROOM
Dept:
Room:
Operator:

Rate	110
RR	545
PR interval	174
QRSD	93
QT	399
QTc	540
----- AXIS -----	
P	-4
QRS	-3
T	51

Sinus tachycardia ---------- rate> 99
Multiform ventricular premature complexes ---------- short R-R, variable morphology
LAE, consider biatrial enlargement ---------- P>80mS <-.15mV V1&>.25mV limb lds
Baseline wander in lead(s) V1,V2,V4,V5,V6
Partial missing lead(s): V2

[UID : S813B29246590014]
[PID : 916238 / Date : 2024-11-29]
Unconfirmed Diagnosis

- ABNORMAL ECG -



RE1001 Speed: 25 mm/sec Limb: 10 mm/mV Chest:10 mm/mV F 60~ 0.05 - 150 Hz W INFINITT CIS

ADM

2024/11/29

- Admitted for scheduled operation
- Pre-op survey: generally normal

OP day

2024/11/30

- Bilateral total thyroidectomy + left neck level II-IV lymph node dissection
- Peri-operative hypertensive crisis (SBP 270 mmHg) and VPCs were noted during surgery
  → Check EKG and cardiac enzyme: LBBB, mild elevated troponin-T
- Denied chest pain, chest tightness, cold sweating, radiation pain
  → Plan: Keep cardiac enzyme follow up

916238 2024-11-30 22:34:14
0 Year Unknown

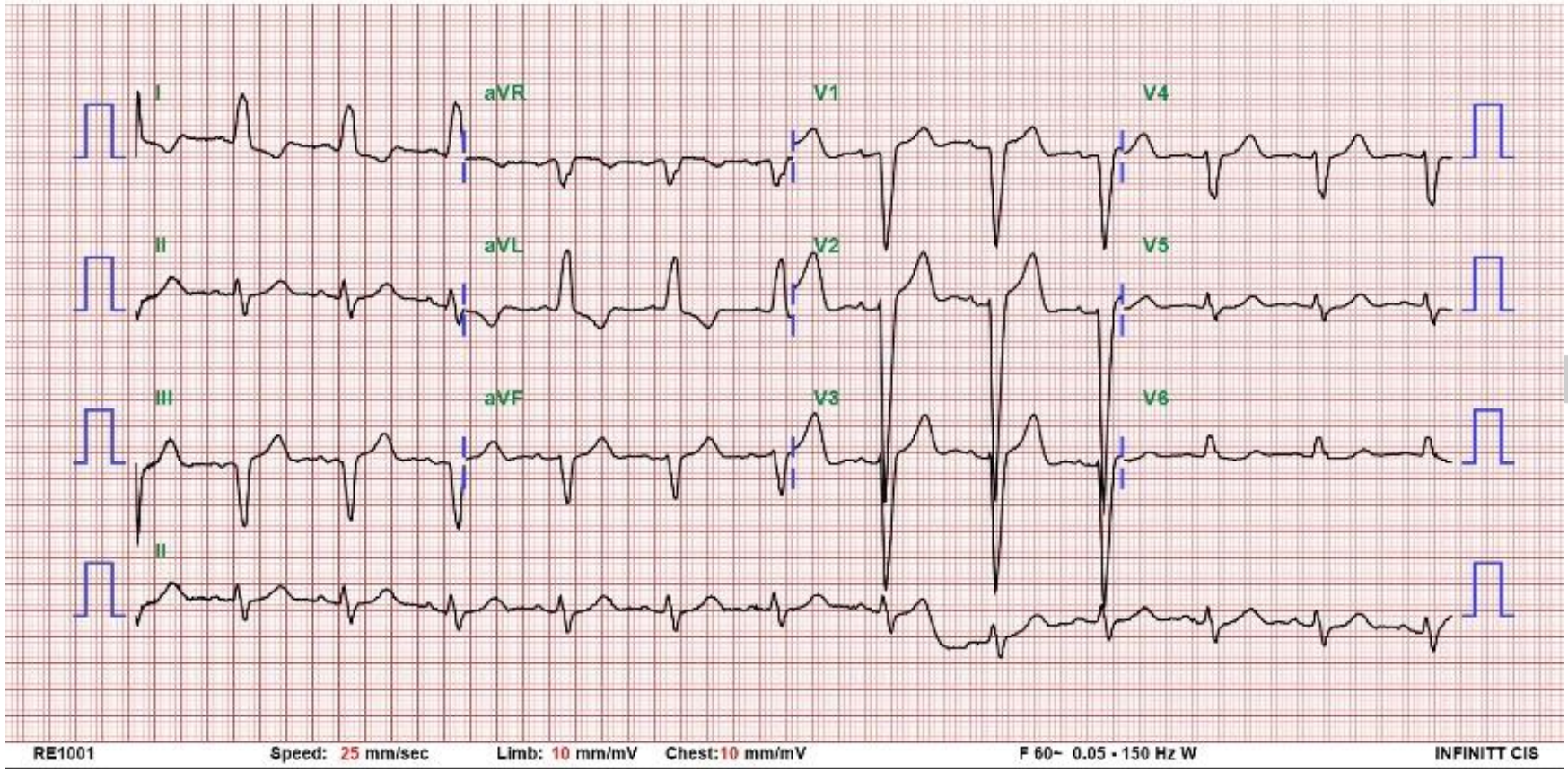
Institution: 07G
Dept:
Room:
Operator:

Rate	73
RR	822
PR interval	175
QRSD	147
QT	470
QTc	518
..... AXIS	
P	15
QRS	-34
T	114

Age not entered, assumed to be 50 years old for purpose of ECG interpretation
Sinus rhythm ..... normal P axis, V-rate 50- 99
Left bundle branch block ..... QRSd>120, broad/notched R
Baseline wander in lead(s) V1,V2,V3,V4,V5

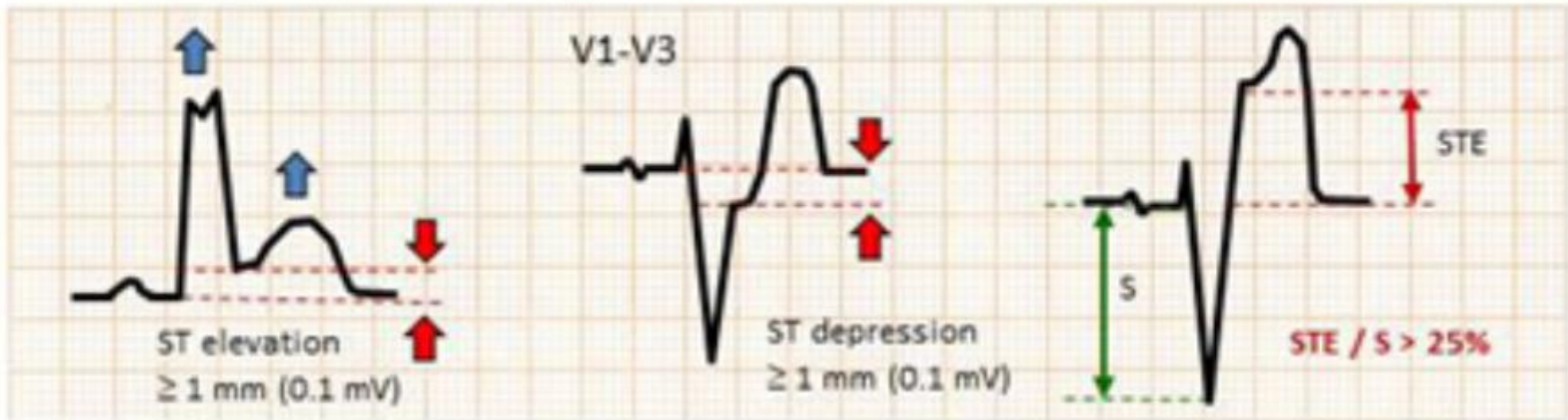
[PID : 916238 / Date : 2024-11-30]
Unconfirmed Diagnosis

- ABNORMAL ECG -

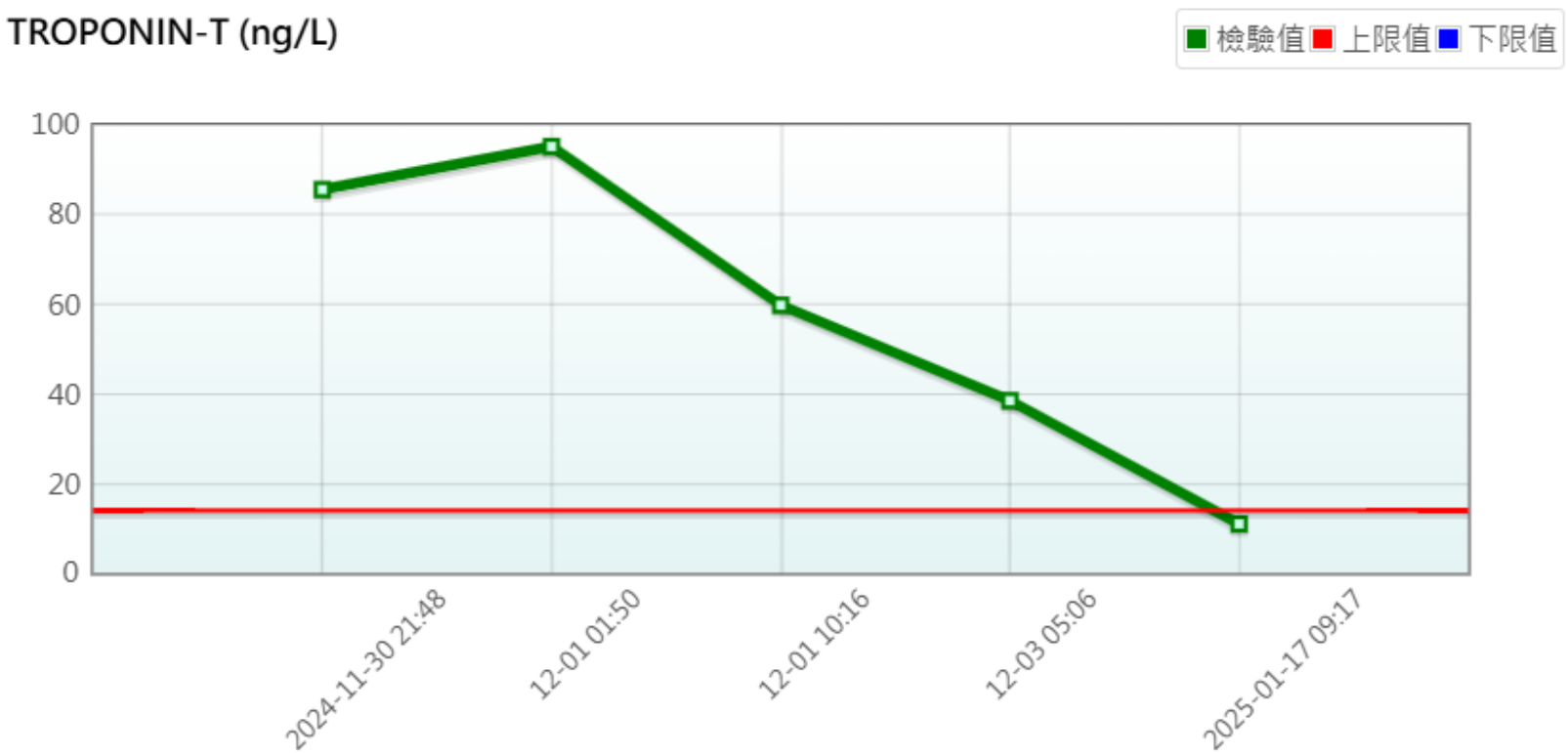


RE1001 Speed: 25 mm/sec Limb: 10 mm/mV Chest:10 mm/mV F 60~ 0.05 - 150 Hz W INFINITT CIS

Modified Sgarbossa criteria



CPK	Blood	114	U/L
CK-MB	Blood	13	U/L
TROPONIN-T	Blood	85.6	ng/L



ADM

2024/11/29

- Admitted for scheduled operation
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OP day

2024/11/30

- Bilateral total thyroidectomy + left neck level II-IV lymph node dissection
- Peri-operative hypertensive crisis (SBP 270 mmHg) and VPCs were noted during surgery
  → Check EKG and cardiac enzyme: LBBB, mild elevated troponin-T
- Denied chest pain, chest tightness, cold sweating, radiation pain
  → Plan: Keep cardiac enzyme follow up

POD 2

2024/12/02

- Complained about face and bilateral hand numbness
- Lab: hypocalcemia

Ca (Blood)

(預設顯示最近10年之資料)

◉ 預設 ○ 一個月內 ○ 三個月內 ○ 一年內 ○ 三年內 ○ 所有資料(會被截至100年999筆內)

資料列表 | 趨勢圖

簽收日期	檢查數值	單位	正常值(Low)	正常值(High)
2025-02-12 09:11	7.0	mg/dL	8.6	10.3
2025-02-03 13:43	7.1	mg/dL	8.6	10.3
2025-01-17 09:17	6.2	mg/dL	8.6	10.3
2025-01-10 10:43	6.2	mg/dL	8.6	10.3
2025-01-02 20:41	6.5	mg/dL	8.6	10.3
2024-12-31 15:10	6.8	mg/dL	8.6	10.3
2024-12-09 16:38	9.8	mg/dL	8.6	10.3
2024-12-05 07:39	7.2	mg/dL	8.6	10.3
2024-12-04 06:49	6.6	mg/dL	8.6	10.3
2024-12-03 05:06	6.3	mg/dL	8.6	10.3
2024-12-02 09:29	6.5	mg/dL	8.6	10.3
2024-11-29 13:25	8.9	mg/dL	8.6	10.3

ADM

2024/11/29

- Admitted for scheduled operation
- Pre-op survey: generally normal

OP day

2024/11/30

- Bilateral total thyroidectomy + left neck level II-IV lymph node dissection
- Peri-operative hypertensive crisis (SBP 270 mmHg) and VPCs were noted during surgery
  → Check EKG and cardiac enzyme: LBBB, mild elevated troponin-T
- Denied chest pain, chest tightness, cold sweating, radiation pain
  → Plan: Keep cardiac enzyme follow up

POD 2

2024/12/02

- Complained about face and bilateral hand numbness
- Lab: hypocalcemia

POD 3

2024/12/03

- Persisted face and bilateral hand numbness, leg twitching also noted
- EKG: intermittent LBBB
- Lab: hypocalcemia and hypokalemia

916238 2024-12-01 16:44:20
0 Year Unknown

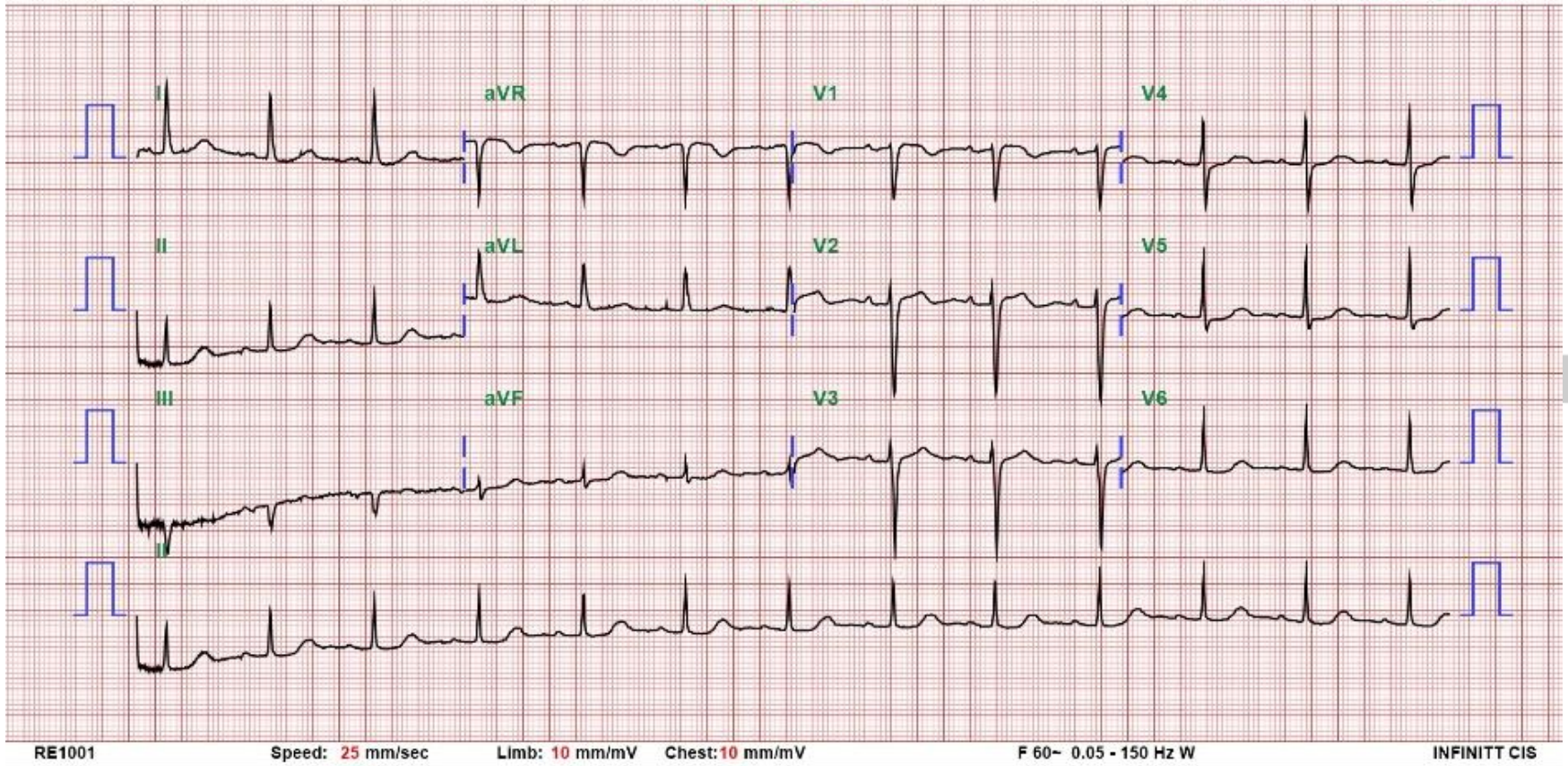
Institution:
Dept:
Room:
Operator:

Rate	76
RR	789
PR interval	187
QRSD	92
QT	426
QTc	480
----- AXIS -----	
P	9
QRS	0
T	29

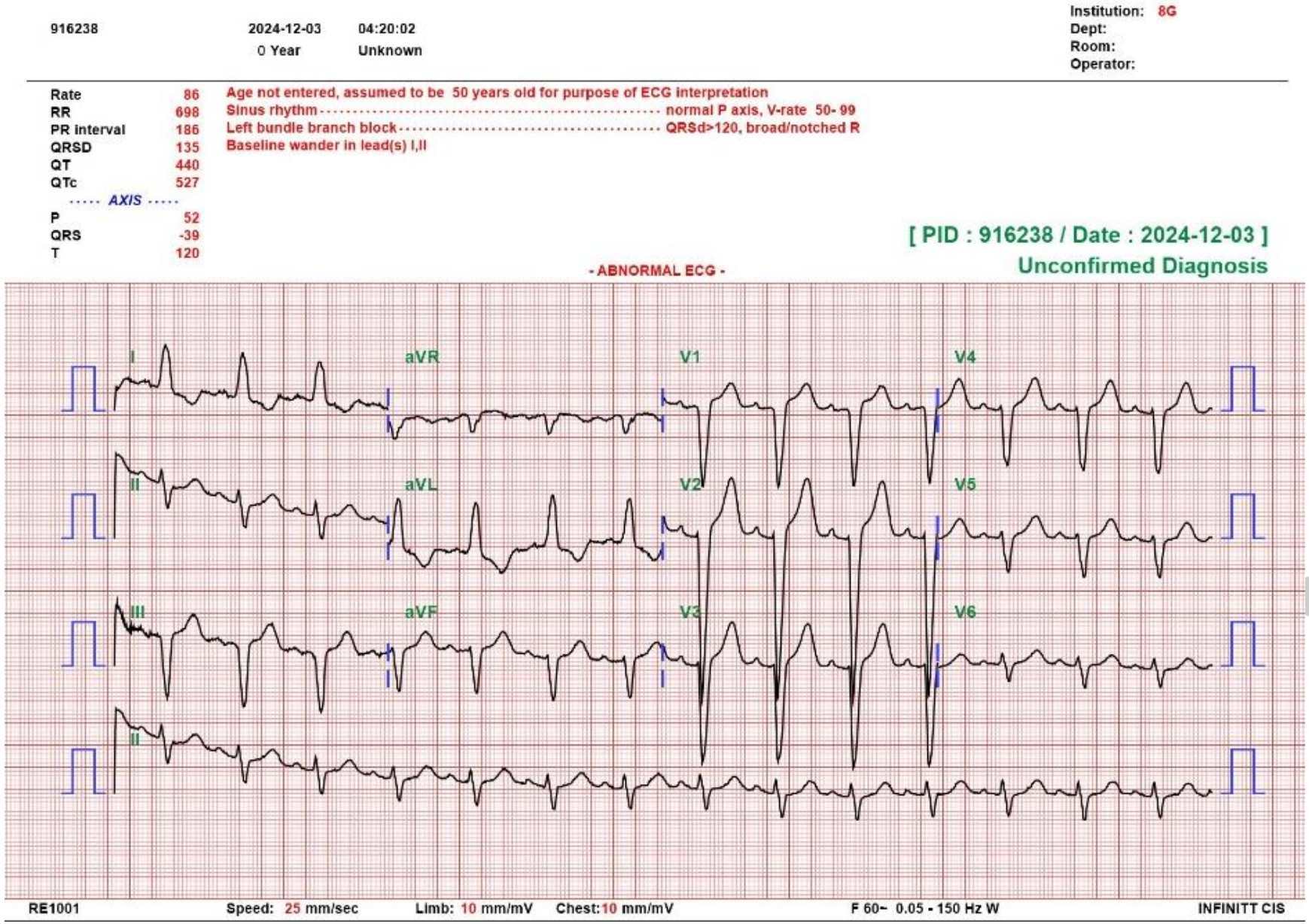
Age not entered, assumed to be 50 years old for purpose of ECG interpretation
Sinus rhythm ---------- normal P axis, V-rate 50- 99
Borderline prolonged QT interval ---------- QTc >475mS

[PID : 916238 / Date : 2024-12-01]
Unconfirmed Diagnosis

- BORDERLINE ECG -



RE1001 Speed: 25 mm/sec Limb: 10 mm/mV Chest: 10 mm/mV F 60~ 0.05 - 150 Hz W INFINITT CIS


916238
2024-12-03 04:20:02
0 Year Unknown
Institution: 8G
Dept:
Room:
Operator:
Rate 86
RR 698
PR interval 186
QRSD 135
QT 440
QTc 527
AXIS
P 52
QRS -39
T 120
Age not entered, assumed to be 50 years old for purpose of ECG interpretation
Sinus rhythm ---------- normal P axis, V-rate 50- 99
Left bundle branch block ---------- QRSd>120, broad/notched R
Baseline wander in lead(s) I,II
[PID : 916238 / Date : 2024-12-03]
Unconfirmed Diagnosis
- ABNORMAL ECG -
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
RE1001
Speed: 25 mm/sec
Limb: 10 mm/mV
Chest: 10 mm/mV
F 60~ 0.05 - 150 Hz W
INFINITT CIS

POD 5 2024/12/05

- Pathology report: Papillary carcinoma, pT3bN1bM0, stage II
- Discharged under stable condition
- ENT and CV OPD follow up

檢驗後診斷名稱	1) Thyroid gland, left, thyroidectomy, papillary carcinoma 2) Lymph node, neck, level II-IV, left, lymphadenectomy, carcinoma, metastatic (7/9)

Finding (惡性)

The specimen submitted consists of one thyroid gland measuring 3.1 x 2.3 x 1.5 cm in size and up to 16 gm in weight, fixed in formalin.

Grossly, one ill-defined and tan nodule, measuring 1.3 x 1.1 x 0.7 cm in size, is found within the thyroid parenchyma.

Representative section is taken.

Microscopically, the thyroid nodule is composed of crowded aggregates of neoplastic cells with clear/twisted nuclei, nuclear grooving, irregular nuclear membrane and papillary growth. Immunohistochemically, the tumor cells are positive for TTF-1, HBME-1 and galectin-3 stains, but negative for synaptophysin and calcitonin stains.
The maximal tumor size measures 1.3 cm. Focal soft tissue invasion is seen. The section margin is close (< 1 mm). In addition, some muscular tissue is also adhered to the tumor. If gross extrathyroidal extension invading the strap muscles is present clinically, a pT3b disease should be considered. Otherwise, a pT1b papillary carcinoma is suggested.

Microscopic Checklist:
1. Tumor types: Papillary carcinoma
2. Maximal tumor size: 1.3 cm
3. Lymph-vascular invasion: suspicious
4. Perineural invasion: absent
5. Encapsulation: absent

POD 5

2024/12/05

- Pathology report: Papillary carcinoma, pT3bN1bM0, stage II
- Discharged under stable condition
- ENT and CV OPD follow up

OPD

2024/12/09

- Fair post-operative condition
- Arrange I-131 treatment
- Prescribe Thyroxine and Calcitriol

POD 5

2024/12/05

- Pathology report: Papillary carcinoma, pT3bN1bM0, stage II
- Discharged under stable condition
- ENT and CV OPD follow up

OPD

2024/12/09

- Fair post-operative condition
- Arrange I-131 treatment
- Prescribe Thyroxine and Calcitriol

CV OPD

2024/12/17

- Follow up for new onset LBBB after hypertensive crisis, r/o ICMP
- Thallium scan: no significant inducible myocardium ischemia
- UCG: fair LV contractility (LVEF: 57%), decreased LV strain over basal inferoseptum
- Prescribe Plavix and NTG (PRN)

POD 5

2024/12/05

- Pathology report: Papillary carcinoma, pT3bN1bM0, stage II
- Discharged under stable condition
- ENT and CV OPD follow up

OPD

2024/12/09

- Fair post-operative condition
- Arrange I-131 treatment
- Prescribe Thyroxine and Calcitriol

CV OPD

2024/12/17

- Follow up for new onset LBBB after hypertensive crisis, r/o ICMP
- Thallium scan: no significant inducible myocardium ischemia
- UCG: fair LV contractility (LVEF: 57%), decreased LV strain over basal inferoseptum
- Prescribe Plavix and NTG (PRN)

2025/01/02

- Dizziness and four limbs numbness for 3 days
- Hypocalcemia related → Treated with Vitacal then discharged

Ca (Blood)

(預設顯示最近10年之資料)

◉ 預設 ○ 一個月內 ○ 三個月內 ○ 一年內 ○ 三年內 ○ 所有資料(會被截至100年999筆內)

資料列表 | 趨勢圖

簽收日期	檢查數值	單位	正常值(Low)	正常值(High)
2025-02-12 09:11	7.0	mg/dL	8.6	10.3
2025-02-03 13:43	7.1	mg/dL	8.6	10.3
2025-01-17 09:17	6.2	mg/dL	8.6	10.3
2025-01-10 10:43	6.2	mg/dL	8.6	10.3
2025-01-02 20:41	6.5	mg/dL	8.6	10.3
2024-12-31 15:10	6.8	mg/dL	8.6	10.3
2024-12-09 16:38	9.8	mg/dL	8.6	10.3
2024-12-05 07:39	7.2	mg/dL	8.6	10.3
2024-12-04 06:49	6.6	mg/dL	8.6	10.3
2024-12-03 05:06	6.3	mg/dL	8.6	10.3
2024-12-02 09:29	6.5	mg/dL	8.6	10.3
2024-11-29 13:25	8.9	mg/dL	8.6	10.3

OPD

2025/01/03 ~ 2025/01/20

- Regular lab data follow up

Intact PTH (Blood)

(預設顯示最近10年之資料)

◉ 預設 ○ 一個月內 ○ 三個月內 ○ 一年內 ○ 三年內 ○ 所有資料(會被截至100年999筆內)

資料列表 | 趨勢圖

簽收日期	檢查數值	單位	正常值(Low)	正常值(High)
2025-02-04 07:41	<4.89	pg/mL	6.87	64.87
2024-12-31 15:10	<4.89	pg/mL	6.87	64.87
2024-12-04 16:27	0.74	pg/mL	6.87	64.87

OPD

2025/01/03 ~ 2025/01/20

- Regular lab data follow up

ADM

2025/02/03

- Admitted for scheduled I-131 treatment

2025/02/05

- I-131 treatment, 100 mCi oral
- Mild nausea

OPD

2025/01/03 ~ 2025/01/20

- Regular lab data follow up

ADM

2025/02/03

- Admitted for scheduled I-131 treatment

2025/02/05

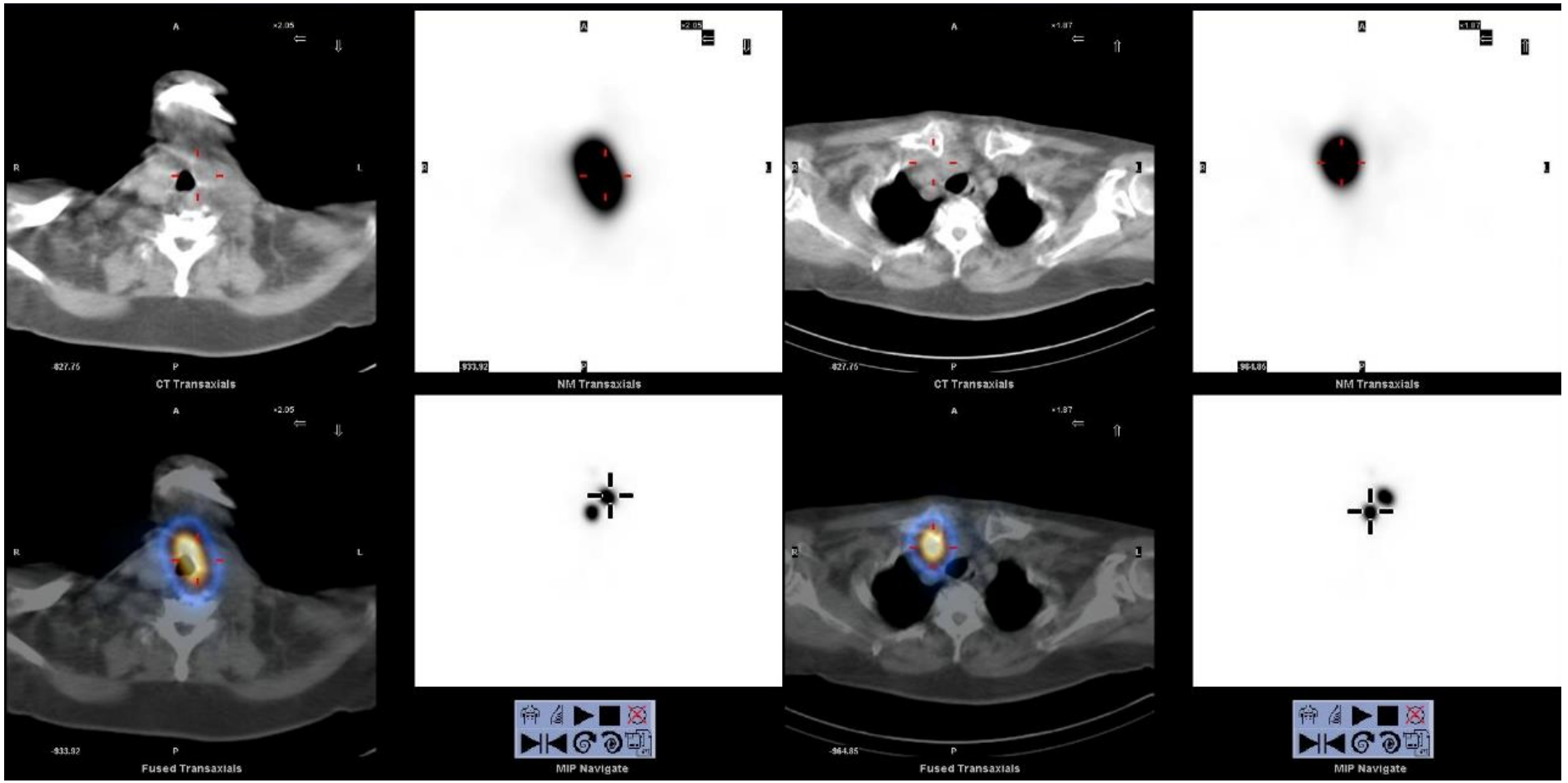
- I-131 treatment, 100 mCi oral
- Mild nausea

2025/02/07

- Discharged under stable condition

2025/02/12

- I-131 cancer workup:
  Intense radioiodine uptake at L't thyroid region and LN at R't upper mediastinum level VII
  No other obvious distant metastasis detected



Final diagnosis

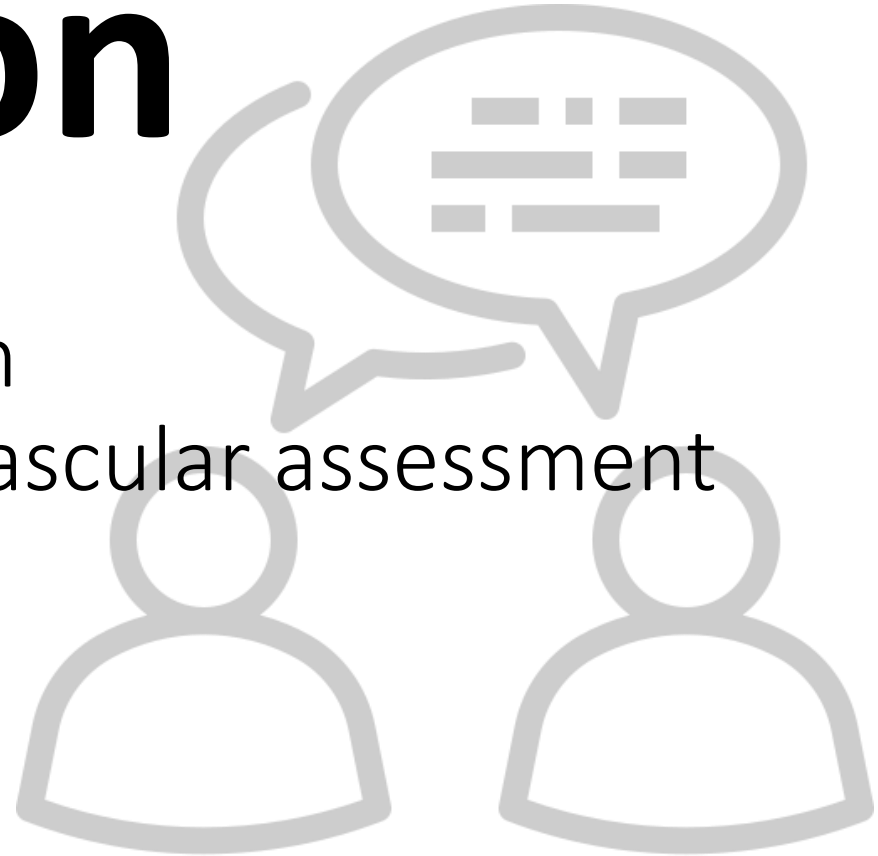
- Thyroid papillary carcinoma, left level II-IV metastatic carcinoma, pT3bN1bM0, stage II, status post bilateral total thyroidectomy + left neck dissection on 2024/11/30
  status post I-131 treatment on 2025/02/05

- Postoperative hypoparathyroidism, causing hypocalcemia

- Hypertensive heart disease

Discussion

Parathyroid
Hypoparathyroidism
Parathyroid gland identification and Vascular assessment



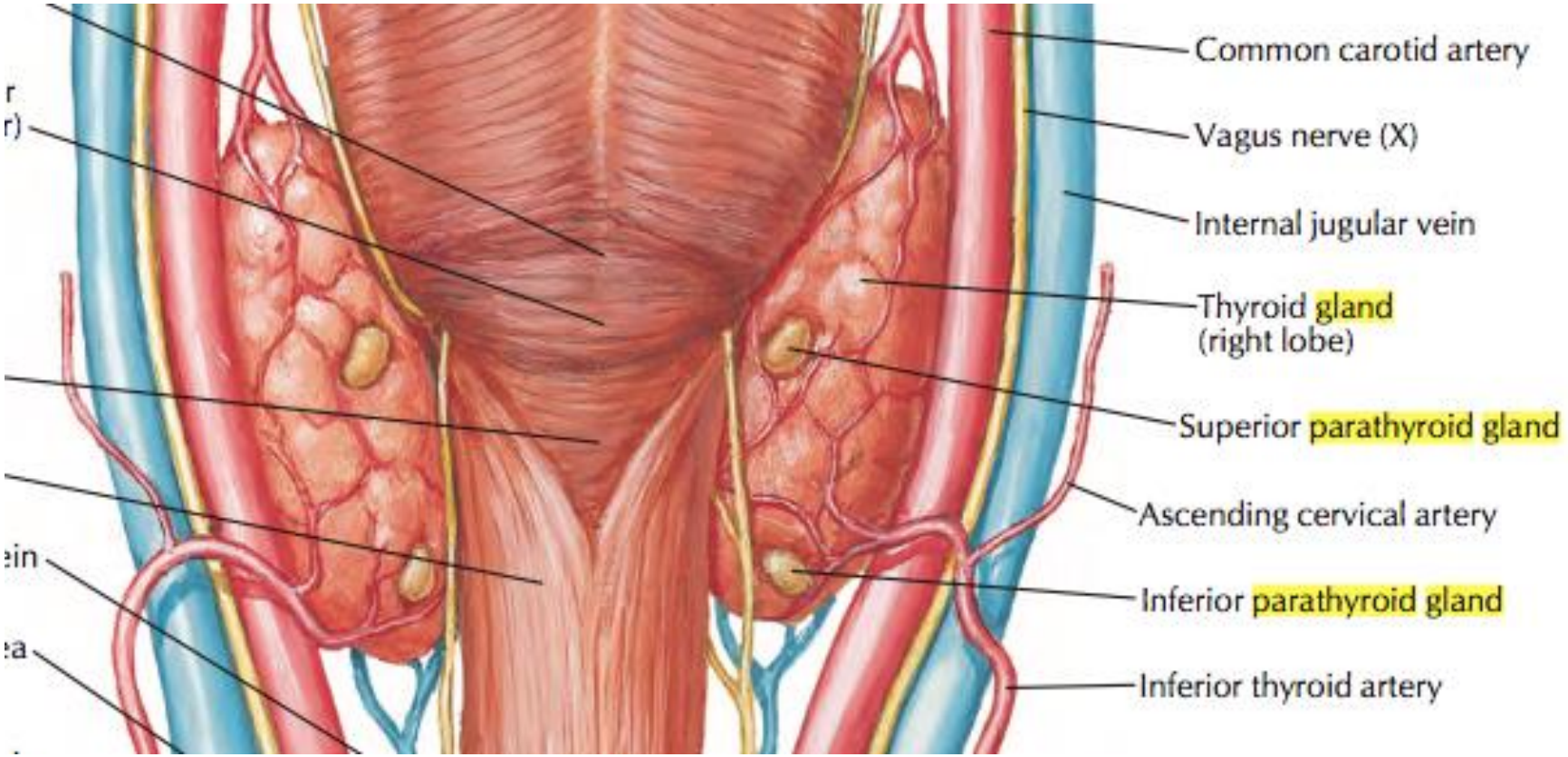
Surgical anatomy of the parathyroid glands

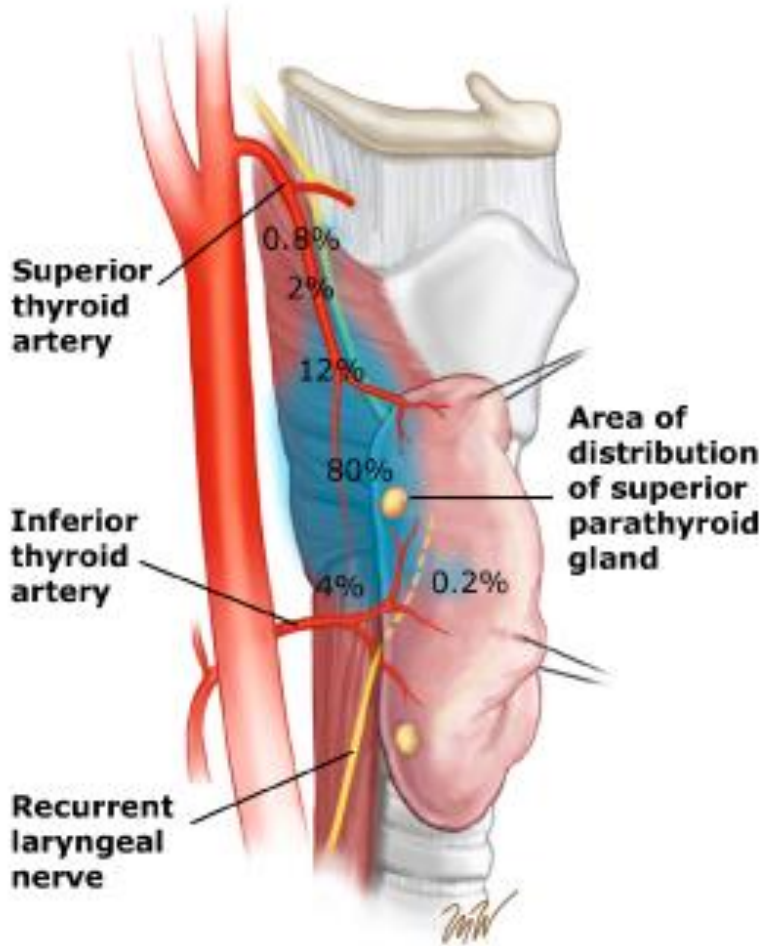
- 84% have four parathyroid glands
  13% have additional glands
  < 3% have only three glands

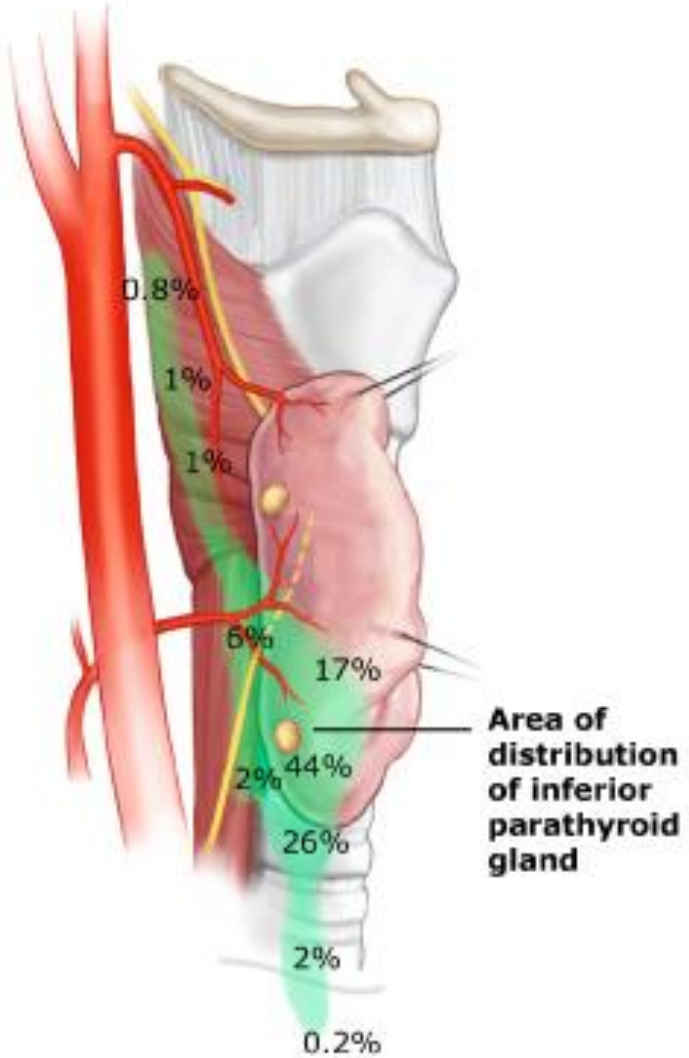
- Ectopic parathyroid glands:
  Parathyroid tissue may co-locate with tissues that have a similar embryologic development

  102 patients with persistent or recurrent hyperparathyroidism, ectopic glands were found in:
  paraesophageal position 28%, mediastinum 26%, intrathymically 24%, intrathyroidally 11%, in carotid sheath 9%, high cervical position 2%

UpToDate - Surgical anatomy of the parathyroid glands


Common carotid artery
Vagus nerve (X)
Internal jugular vein
Thyroid gland
(right lobe)
Superior parathyroid gland
Ascending cervical artery
Inferior parathyroid gland
Inferior thyroid artery





UpToDate - Surgical anatomy of the parathyroid glands

Surgical anatomy of the parathyroid glands

- Blood supply:
  Artery:
  branches of the inferior thyroid artery
  (superior parathyroid glands can also be supplied by branches of the superior thyroid artery in 15~20% of patients)
  80% have a single arterial supply
  15% have a dual artery supply
  5% have multiple arterial supply

  Vein:
  superior, middle, and inferior thyroid veins that drain into the internal jugular vein or the innominate vein

UpToDate - Surgical anatomy of the parathyroid glands

Parathyroid preservation

- Parathyroid glands should not be removed during thyroid surgery unless they are grossly invaded by a thyroid malignancy or become severely ischemic during dissection.

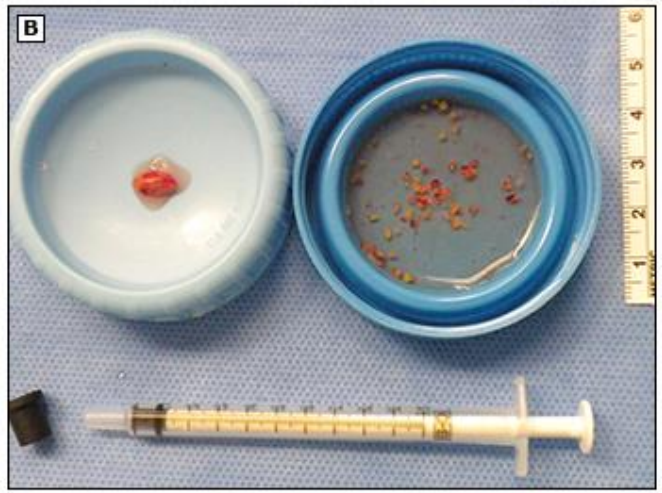
- Parathyroid gland can be autotransplanted into a well-vascularized muscle such as the strap or sternocleidomastoid muscles

- Before transplantation, frozen section of a small portion of the gland may be performed to ensure that the tissue is indeed of parathyroid origin, rather than of a metastatic lymph node or a portion of the thyroid gland.

- Fine-needle aspiration followed by rapid intraoperative PTH measurement of the aspirate is another way to confirm parathyroid tissue.

UpToDate - Thyroidectomy

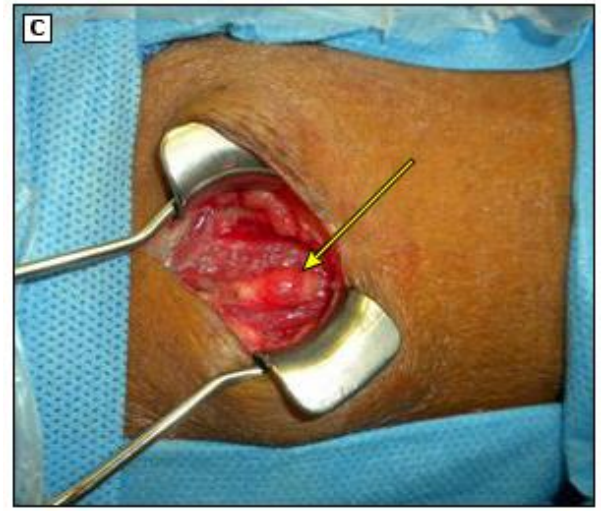

A


B


C


A


B


C

Hypoparathyroidism and hypocalcemia

- Symptoms of hypocalcemia
  Mild: paresthesia around the lips, mouth, hands, and feet
  Moderate: muscle twitches or frank cramps
  Severe: trismus or tetany

- Transient hypoparathyroidism: 0.3~49% of patients after thyroidectomy
  Permanent hypoparathyroidism: up to 13%

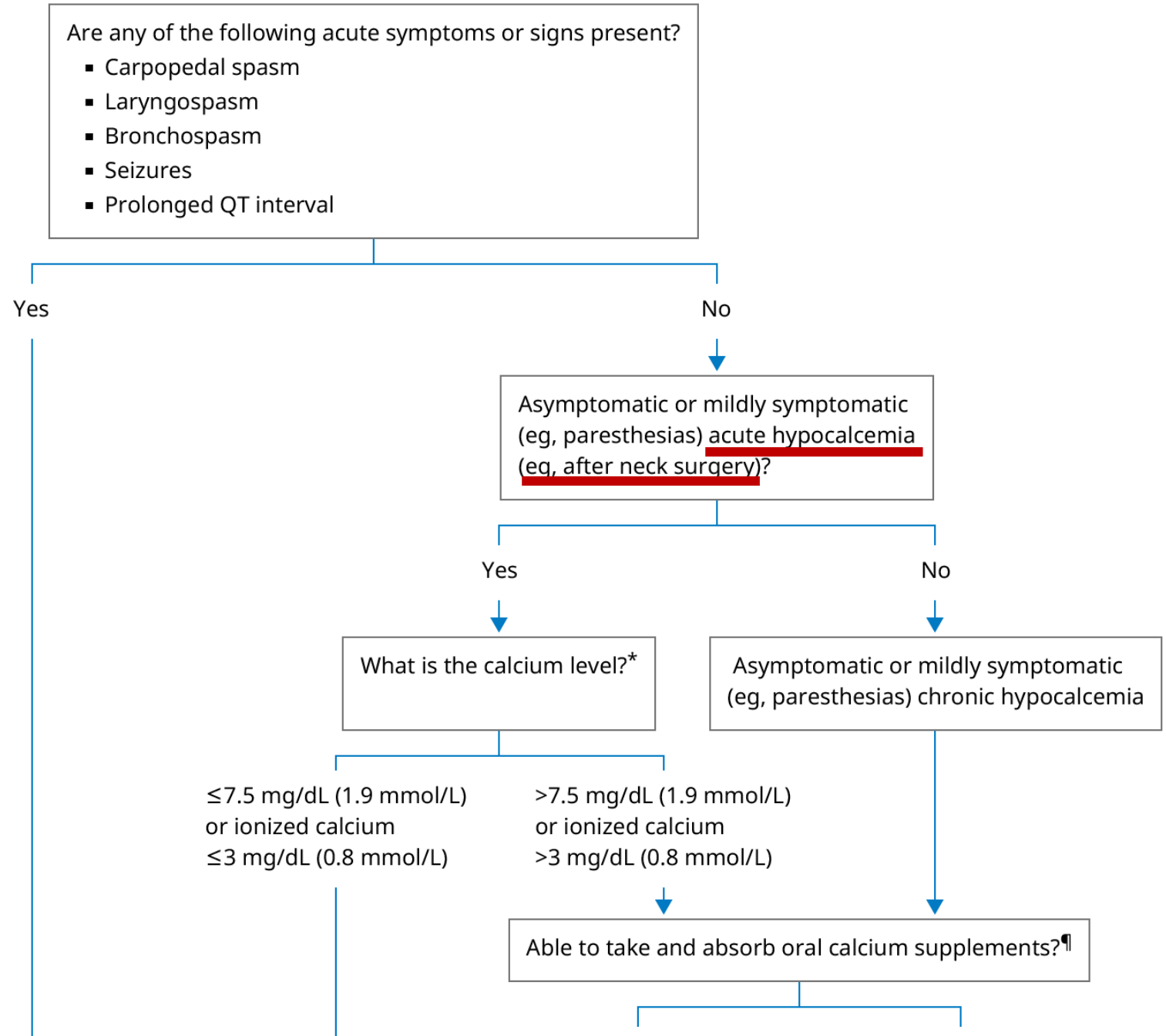
- Therapy goals:
  relieve symptoms, raise and maintain the serum calcium concentration

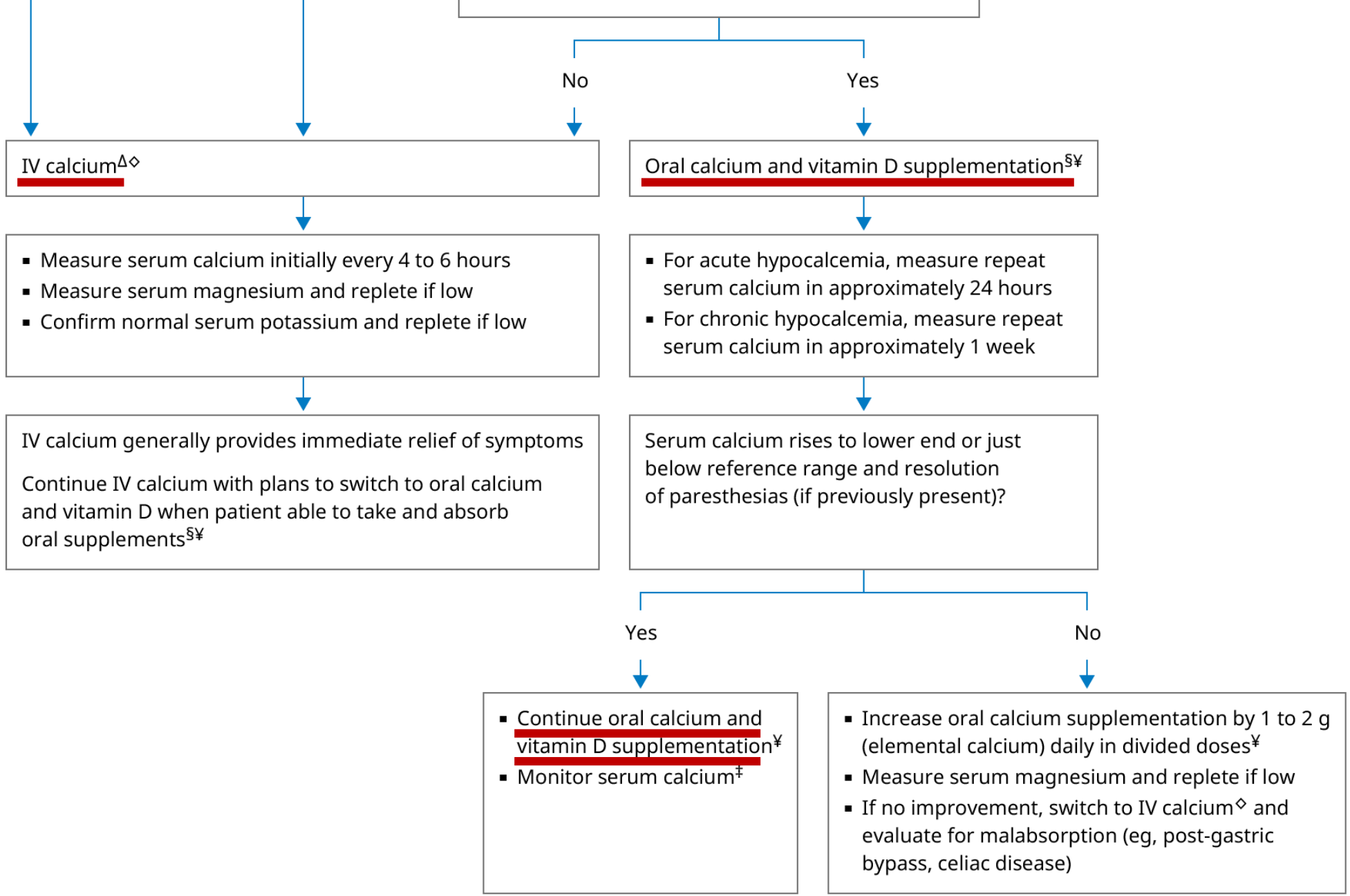
UpToDate - Thyroidectomy

Management of adults with hypocalcemia after thyroid surgery

Postoperative day	Serum tests	Therapy
Night of surgery	Calcium in the evening (approximately 8 PM)	**Ca <7.5 mg/dL:** Calcitriol 0.5 mcg three times daily x three days and calcium gluconate 3 g/L D5 1/2 normal saline IV at 100 mL/hour
Day 1	Calcium and phosphorus in the morning (approximately 6 AM); if Ca <7.5 mg/dL, add magnesium	**Ca <7.5 mg/dL:** Calcitriol 0.5 mcg twice daily x three days and adjust depending upon calcium response and calcium gluconate 3 g/L D5 1/2 normal saline IV at 100 mL/hour and calcium carbonate (1 to 4 g elemental calcium) by mouth daily in divided doses depending upon calcium response **Ca 7.5 to 8.0 mg/dL:** Calcitriol 0.5 mcg twice daily x three days and adjust depending upon calcium response and calcium carbonate (1 to 4 g elemental calcium) by mouth daily in divided doses depending upon calcium response **Ca >8.0 mg/dL:** Calcium carbonate (1 g elemental calcium) by mouth twice daily **Mg <2 mg/dL:** Magnesium sulfate 4 g in 100 mL normal saline IV at 33 mL/hour and magnesium oxide 400 mg by mouth twice daily x one month
Day 2 to 4	If day 1 Ca ≤8.0 mg/dL, total calcium and phosphorus	**Ca <7.5 mg/dL and symptomatic:** Calcitriol 0.25 mcg three times daily and calcium gluconate 3 g/L D5 1/2 normal saline IV at 100 mL/hour and calcium carbonate (1 to 4 g elemental calcium) by mouth daily in divided doses and modify based upon calcium response **Ca <7.5 mg/dL and asymptomatic:** Calcitriol 0.25 mcg three times daily and calcium carbonate (1 to 4 g elemental calcium) by mouth daily in divided doses and modify based upon calcium response **Ca 7.5 to 8.4 mg/dL or P ≥4.5 mg/dL:** Calcitriol 0.25 mcg daily and calcium carbonate (1 to 4 g elemental calcium) by mouth daily in divided doses and modify based upon calcium response **Ca 8.5 to 9.4 mg/dL and P ≤4.5 mg/dL:** Calcium carbonate (1 to 4 g elemental calcium) by mouth daily in divided doses and modify based upon calcium response **Ca ≥9.5 mg/dL:** No therapy

Initial management of hypocalcemia in adults without chronic kidney disease-mineral and bone disorder





D5W: 5% dextrose; IV: intravenous; NS: normal saline.

* Ionized calcium remains the gold standard for assessing calcium status, particularly if the diagnosis of hypocalcemia is in doubt due to hypoalbuminemia, atypical or absent symptoms, or a minimally reduced serum calcium concentration. If a laboratory known to measure ionized calcium reliably is not available, the total calcium should be corrected for any abnormalities in serum albumin, using a calcium correction formula.

¶ In patients with milder degrees of hypocalcemia or chronic hypocalcemia (due to hypoparathyroidism) who become unable to take or absorb oral supplements, as may occur after complex surgical procedures requiring prolonged recuperation, IV calcium may be needed to prevent acute hypocalcemia.

JAMA Otolaryngology–Head & Neck Surgery | Review

Emerging Imaging Technologies for Parathyroid Gland Identification and Vascular Assessment in Thyroid Surgery

A Review From the American Head and Neck Society Endocrine Surgery Section

Introduction

- Hypoparathyroidism is an endocrine disorder characterized by low calcium and absent or insufficient circulating parathyroid hormone

- Most common: surgical injury
  Less common: autoimmune or genetic disorders

- Permanent postoperative hypoparathyroidism (failure of functional recovery 6 to 12 months after thyroidectomy) rate range from 4%~12%

- Identification and preservation of parathyroid glands remains challenging despite advances in surgical techniques.

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Introduction

- The morbidity associated with hypoparathyroidism following thyroid surgery:
  → Decreased quality of life
  → Kidney, neurologic, and musculoskeletal complications

- Management of permanent postoperative hypoparathyroidism:
  → Calcium supplements, activated vitamin D, magnesium, thiazide diuretics, phosphate binders, dietary/lifestyle changes, and recombinant human intact PTH

- Using surgical technologies to prevent PG injury is therefore important

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Parathyroid Gland Identification

- NIR fluorescence systems for thyroid surgery can be divided into 2 groups: probe based and camera based
- The NIRAF imaging can identify 90% to 100% of PGs with 90% to 100% sensitivity and accuracy
- In one study, when compared concurrently in the same set of 20 patients, probe-based NIRAF was more sensitive in PG identification vs camera image–based NIRAF (detection rate of 97% and 91%, respectively)

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Near-Infrared Autofluorescence

- Autofluorescence occurs when certain endogenous tissue fluorophores (molecules with specific characteristics with respect to light) spontaneously re-emit light of longer wavelengths (lower energy) after illumination by light of shorter wavelengths (higher energy)

- PGs were reported to autofluorescence 2-11 times brighter than surrounding tissues, including thyroid tissue, under near-infrared (NIR) light at ~820 nm

- When laser light of 785 nm wavelength illuminates PGs, they spontaneously emit light in the near-infrared spectrum with a peak at 820-830 nm, which can be seen using detection fiber probes or cameras specially developed to detect light in the NIR spectrum.

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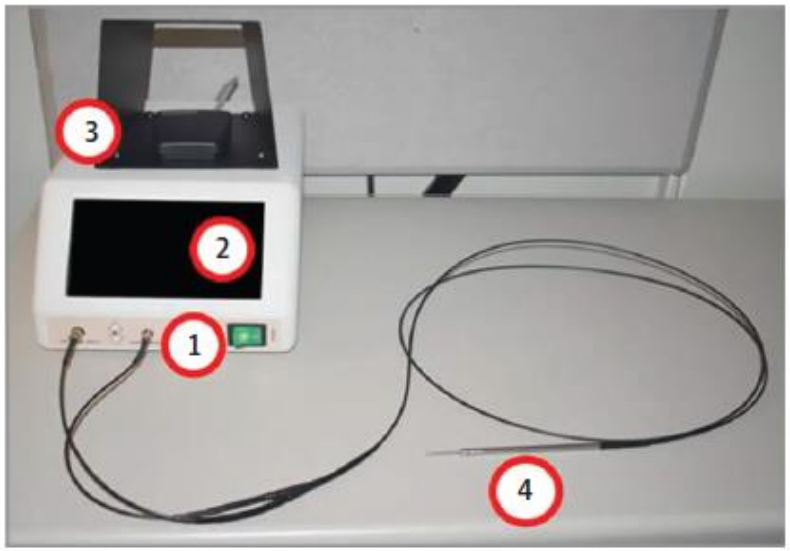
Figure 1. Probe-Based Technology

A PTeye

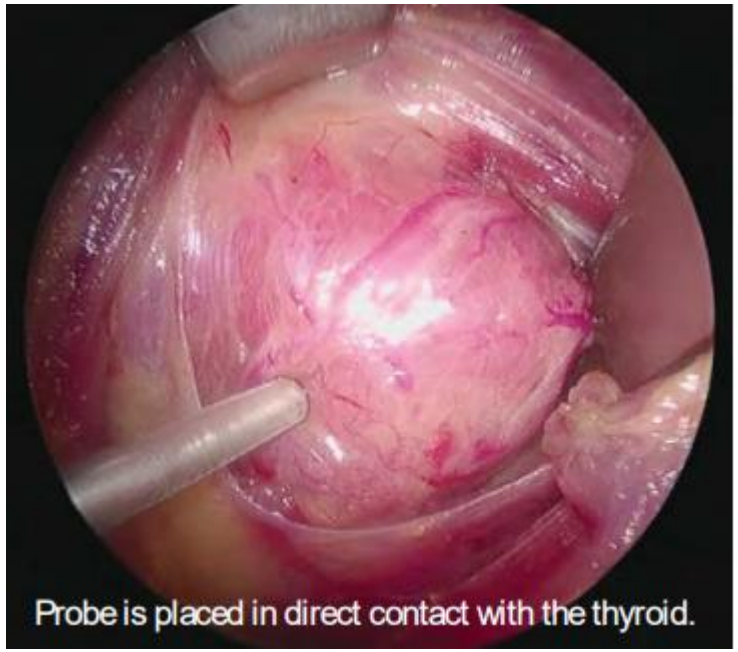


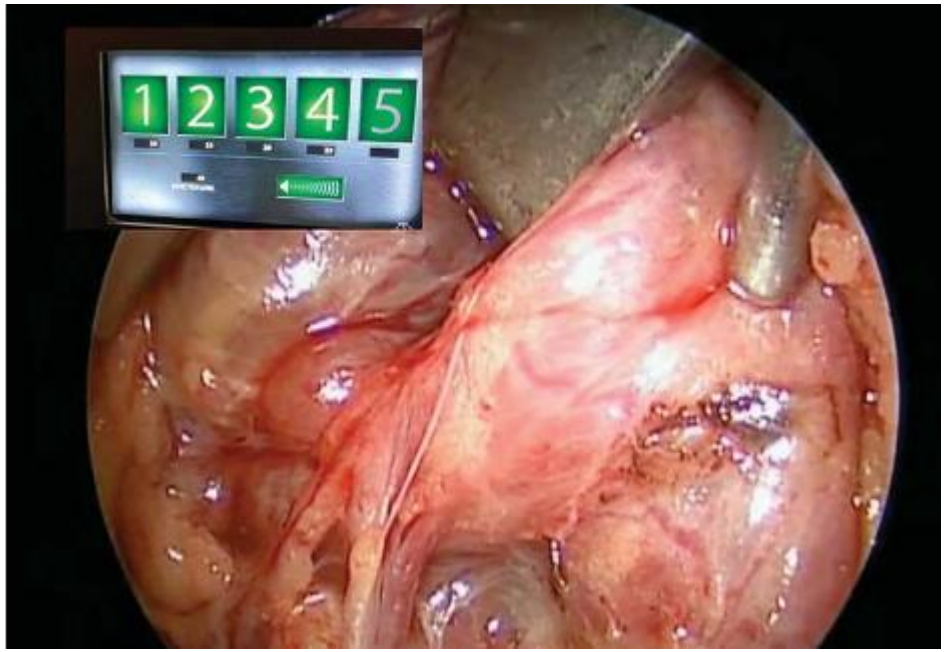
B Fiber-optic probe

C Parathyroid

D Not parathyroid

A, PTeye (Medtronic) consists of (1) a console that houses a near-infrared (NIR) laser and a detector, (2) a display interface that informs whether the tissue is a parathyroid or not, (3) a foot pedal that enables NIR illumination of tissue, and (4) a sterile detachable fiber-optic probe. B, The sterile fiber-optic probe of PTeye is placed in contact with tissue for NIR illumination and subsequent NIR autofluorescence detection. C and D, PTeye display interface indicates whether the tissue under investigation is a parathyroid or not. These images are published with credit to Drs Carmen C. Solórzano and Giju Thomas.


Probe is placed in direct contact with the thyroid.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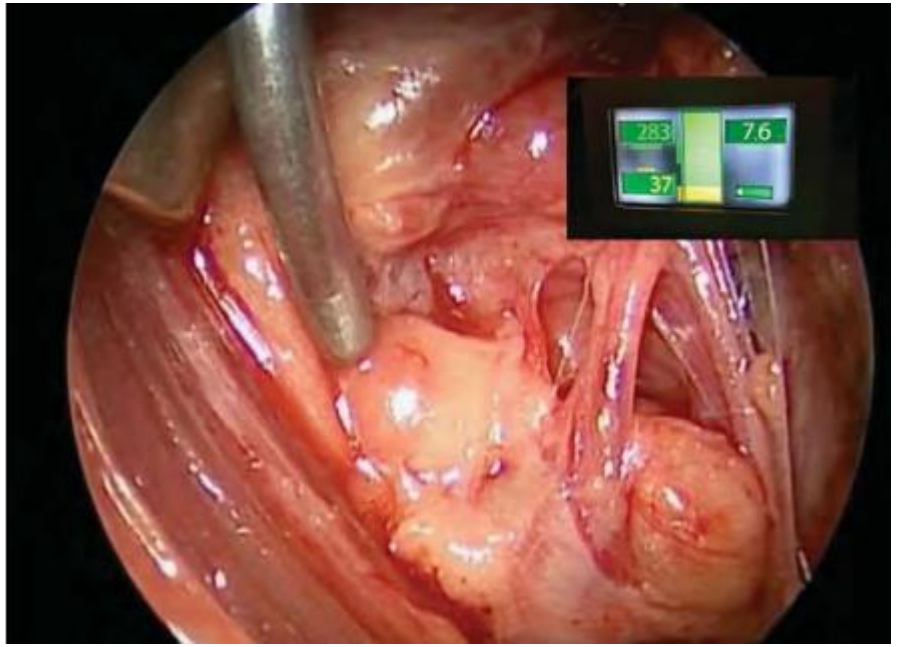
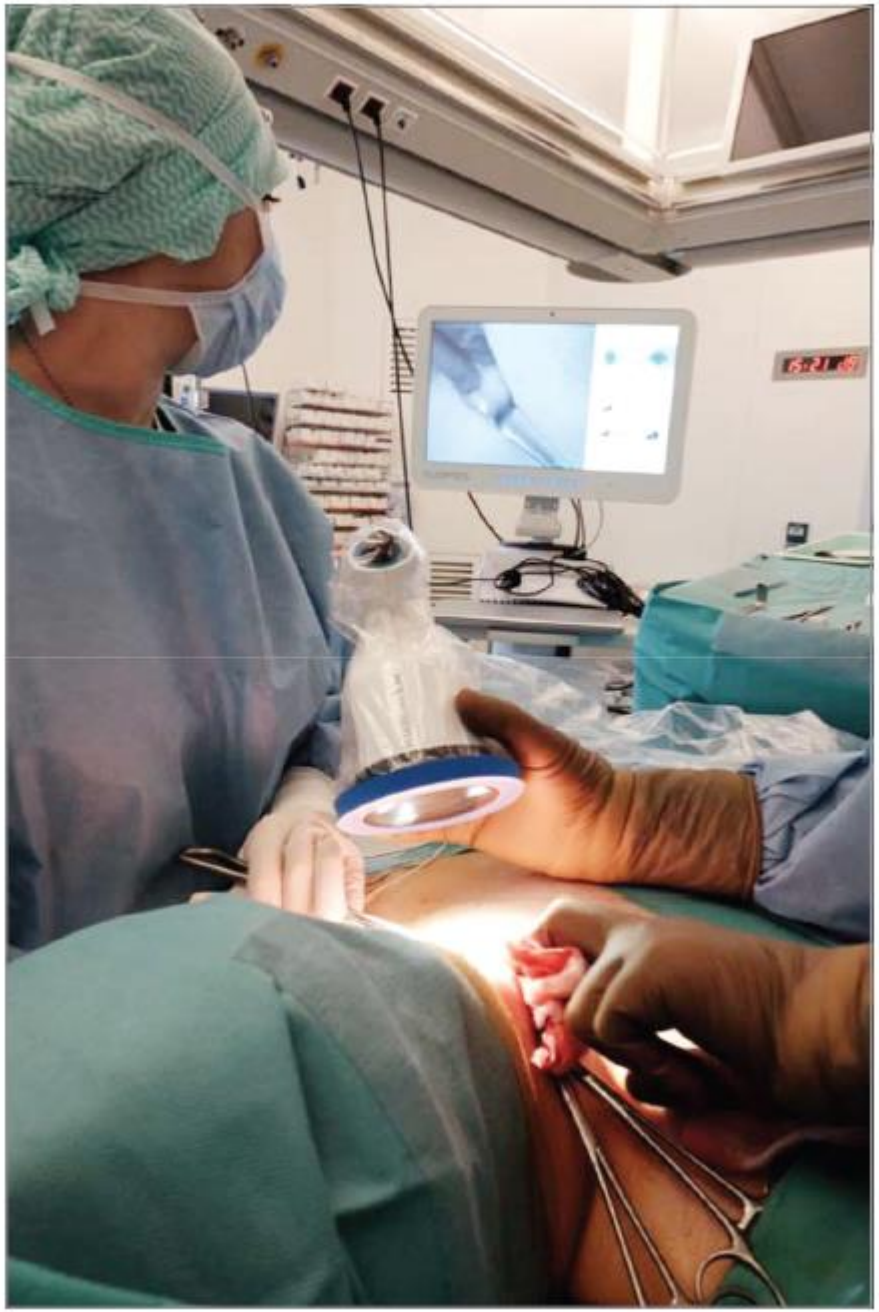
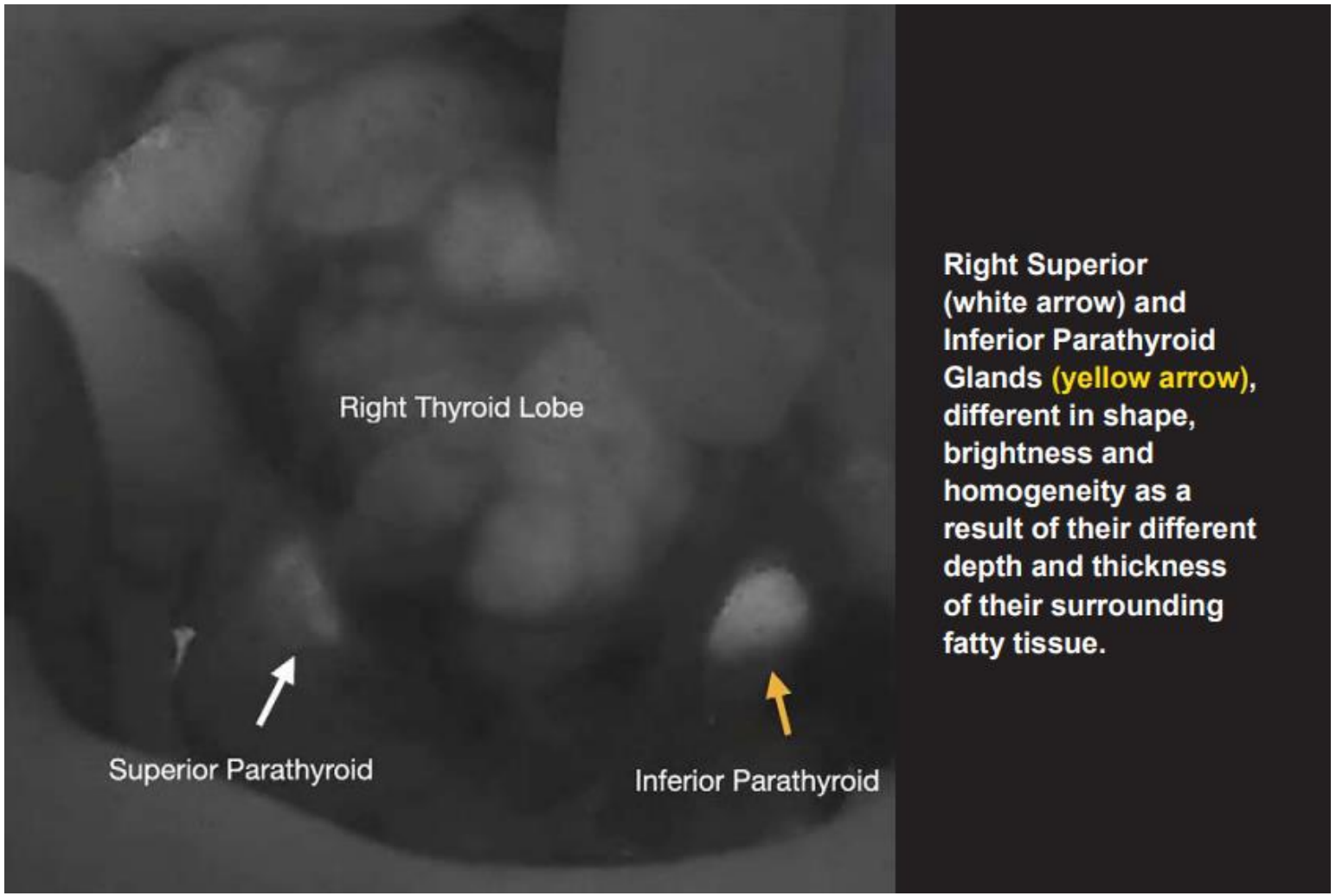

283
7.6
37

Figure 2. Camera-Based Technology





Probe-based detection	Camera-based NIR detection
• FDA cleared (PTeye) • Repeated intraoperative use possible • Real-time tissue evaluation • Real-time detection level, detection ratio, and auditory signal • May reduce frozen section use • Contrast or dye free • Compact device suitable for smaller incisions • Measurement only of area of interest; not affected by fluorescence from other sources	• FDA cleared (Fluobeam 800 and LX) • FDA approved for contrast-enhanced NIR fluorescence detection (EleVision, ENV, Firefly, FLARE, Fluobeam 800 and LX, IMAGE1 SPIES, Karl Storz Opal1, Olympus, PDE Neo II, PinPoint, Quest Spectrum, SPY, SPY-PHI, 1588 AIM) • Repeated intraoperative use possible • Real-time tissue evaluation • Global or wide-surgical field view (PG in context of surrounding structures) • May reduce frozen section use • Contrast or dye free • Contactless • Can be combined with ICG systems
• Learning curve to set baseline fluorescence to avoid false positives/negatives • No wide global surgical view • User must correlate with anatomy in real time • Requires disposable probe to be in contact with tissue of interest	• Quantitative data not yet standardized or available in real time • Learning curve for correct camera position (distance, angle, etc) • User must correlate surgical field and anatomy with remote monitor image • Requires disposable sterile plastic cover • Vicryl sutures, surgical sponges, and surgical ink can interfere with fluorescence • Camera not optimized for smaller surgical incisions

Parathyroid Gland Vascularization

- Intraoperative assessment of parathyroid perfusion:
  Indocyanine green (ICG) can be injected before thyroid resection to identify PG feeding vessels
  Others: laser speckle contrast analysis-based angiography, OCT angiography, and photoacoustic angiography

- NIRAF in conjunction with ICG imaging may provide information about perfusion and perhaps postoperative PG function

- Camera-based NIRAF detection methods and predissection ICG injection may provide a spatial guide of PG and associated vascular anatomy

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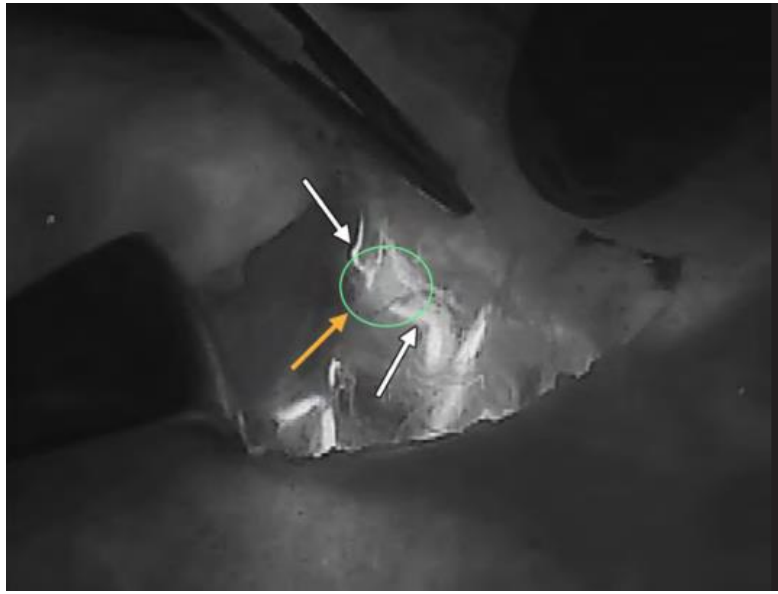
First side (left side):
Before dissection, the
left superior parathyroid
(yellow arrow) and its
potential pedicles
(white arrows) are visible



Second side (right side):
Before dissection,
the right superior
parathyroid (yellow arrow,
area circled in green)
and its potential pedicles
(white arrows) are visible.

Table. Clinical Studies With Use of ICG Angiography in Thyroidectomy

Source	Type of study	No. of patients	PGs identified (ICG scoring)	Postoperative PG function
Zaidi et al,[47] 2016	Case series	27	71/85 (0-3)[a]	Higher fluorescence score correlated with higher postoperative day 1 PTH
Vidal Fortuny et al,[49] 2016	Prospective cohort	36	91/99 (0-2)[a]	≥1 Well-perfused PG correlated with normal PTH
Yu et al,[40] 2017	Case control	22	32/32	4/22 Transient hypoparathyroidism
				1/22 Permanent hypoparathyroidism
Lang et al,[50] 2017	Prospective cohort	94 (70 with 4 PGs identified)	324/340 (calculated GFI)[b]	GFI >150% from ≥1 PG correlated with normal PTH
Kahramangil and Berber,[22] 2017	Case series	22	60/63	1/22 Transient hypocalcemia
Alesina et al,[39] 2018	Case report	5	12/12	All normal PTH
Vidal Fortuny et al,[45] 2018	Randomized clinical trial	196	387/499 (0-2)[a]	≥1 Well-perfused PG correlated with normal PTH
Jin et al,[51] 2019	Case series	26	86 (0-2)[a]	22/26 ≥1 Well-perfused PG correlated with normal PTH; 2/4 with no well-perfused PG showed transient hypoparathyroidism

Figure 4. Parathyroid Gland Perfusion Detection Systems

	ICG perfusion detection
Benefits	• FDA approved; low toxicity with few reported adverse events • Repeated injections possible, although results are variable based on timing • Uptake can be quantifiably (or qualitatively) measured • Contactless
Considerations	• Ability to accurately predict postoperative PG function based on ICG perfusion assessment not well established • Requires injection with small risk of anaphylaxis • No standardized dose (current-reported range 2.5-10 mg)[a] • ICG score (interpretation of gray scale image) is subjective and not yet standardized[b] • Thyroid uptake and/or bleeding causing ICG leakage may limit PG visibility • Depth of NIR light penetration (2-3 mm) may limit use to assess deeper or ectopic PGs
Trouble-shooting	• ICG washout duration (>10 min) before exploration of other PG(s) or reinjection
Caution note	• Not to be used in allergy to ICG or pregnancy • Use with caution in allergy to iodide/iodinated contrast media/shellfish

Take home message

- Emerging technologies hold promise to improve PG identification and preservation during thyroidectomy
- An integrated system enabling early PG identification and prediction of postoperative PG function is not yet available
- Additional research is needed to standardize NIRAF signal quantification, standardize the parameters of ICG injection (dosing, timing of injection, and signal quantification), enable this technology to predict postoperative PG function

Reference

- Karcioglu, A. L. S., Triponez, F., Solórzano, C. C., Iwata, A. J., Ahmed, A. H. A., Almquist, M., ... & Randolph, G. W. (2023).
  Emerging imaging technologies for parathyroid gland identification and vascular assessment in thyroid surgery: a review from the American Head and Neck Society Endocrine Surgery Section.
  JAMA Otolaryngology–Head & Neck Surgery, 149(3), 253-260.

- UpToDate - Surgical anatomy of the parathyroid glands

- UpToDate - Thyroidectomy