Supplementary Online Content


Appendix. Surgical Outcome of 176 Reoperative Patients After Stratification of Disease Status by Clinical Scenario

eFigure 1. Outcome of 145 patients who are strongly suspected of having a single remaining abnormal gland. CC indicates completely correct; CI, completely incorrect; FN, false-negative results; FP, false-positive results; LS, localization study; MSD, multiple-site disease; MSE, multiple-site exploration; NE, negative exploration; SSD, single-site disease; and SSE, single-site exploration. *Intraoperative decision to explore multiple sites. Refer to the main article for further explanation.

eFigure 2. Outcome of 16 patients who are strongly suspected of having multiple remaining abnormal glands. CC indicates completely correct; FN, false-negative results; LS, localization study; MSD, multiple-site disease; MSE, multiple-site exploration; SSD, single-site disease; and SSE, single-site exploration. *Intraoperative decision to explore multiple sites. Refer to the main article for further explanation.

eFigure 3. Outcome of 15 patients who could have either a single or multiple remaining abnormal glands. CC indicates completely correct; CI, completely incorrect; FN, false-negative results; FP, false-positive results; LS, localization study; MSD, multiple-site disease; MSE, multiple-site exploration; SSD, single-site disease; and SSE, single-site exploration. *Intraoperative decision to explore multiple sites. Refer to the main article for further explanation.

This supplementary material has been provided by the authors to give readers additional information about their work.
Appendix. Surgical Outcome of 176 Reoperative Patients After Stratification of Disease Status by Clinical Scenario

For the 176 reoperative candidates in this study, their clinical scenarios (CSs) as previously described were reviewed, and they were stratified as having single-site disease (SSD) (n=145, 82%), multiple-site disease (MSD) (n=16, 9%), or unknown disease status (SSD or MSD) (n=15, 9%). Of the 145 patients who were predicted to have SSD by CS and, therefore, who were candidates for single-site exploration (SSE), the aggregate interpretation of localization studies (LSs) revealed a focal signal in 131 patients (90%) and multifocal signals in 14 (10%) (eFigure 1). Of the 131 focal imaging patients, 123 (94%) underwent SSE, where cure was achieved in 120 (98%) after excision of the single abnormal parathyroid gland (120 with SSD) and 3 (2%) had persistent disease after excision of the localized abnormal parathyroid gland. In the 120 cured patients, all had an accurate focal signal on LSs that directed the surgeon to perform a successful SSE. In the 3 patients who failed postoperatively, the LSs were correct with false-negative results because these patients had persistent disease even after excision of the abnormal index lesion. The other 8 patients (6%) who had a focal signal on LSs underwent multiple-site exploration (MSE). Although the initial intended surgical approach was an SSE in these 8 patients, various intraoperative findings changed the operation to an MSE. These findings were as follows: (1) an LS with a false-positive signal on 1 side of the neck led the surgeon to explore the opposite side; (2) an inappropriate drop in the intraoperative parathyroid hormone level after excision of the localized gland caused the surgeon to perform a bilateral neck exploration; (3) 2 abnormal glands were identified during exploration; or (4) no abnormal pathologic findings were seen at the index site. Of the 8 patients who underwent MSE, 6 (75%) were cured and 2 (25%) had negative explorations, where no disease was found (completely incorrect LSs). Of the 6 cured patients, 3 had SSD with completely correct LSs, 1 had MSD with correct with false-negative LSs, and 2 had SSD with completely incorrect LSs. Therefore, the 3 patients with completely correct LS had more extensive surgery than indicated by an accurate focal signal on LSs and the other 3 had appropriate MSE due to false-negative signals or completely incorrect focal signals on LSs. Last, all 14 patients who were predicted to have SSD by CS but who had multifocal signals on LSs underwent MSE, where 13 (93%) were cured and 1 (7%) had a negative exploration. Of the 13 cured patients, 5 had MSD with completely correct LS, 2 had MSD with correct with false-negative LSs, 5 had SSD with correct with false-positive LSs, and 1 had SSD with completely incorrect LSs. Of these 13 patients, 5 with completely correct LSs had appropriate MSE as indicated by accurate multifocal signals on LSs, 2 with correct with false-negative LSs underwent further necessary exploration of nonindex sites due to an inappropriate drop in intraoperative parathyroid hormone even after all correctly localized glands were removed, and the last 6 with correct with false-positive or completely incorrect LSs underwent needless exploration of localized sites that did not reveal any pathologic abnormalities. Overall, in this group of 145 patients with presumed SSD, there were 131 SSD (90%), 8 MSD (6%), 3 failures (2%), and 3 negative explorations (2%). The accuracy of LSs in guiding the surgeon to perform an appropriate and curative exploration occurred in 127 of 145 patients (88%): SSE in 120 and MSE in 7.

Of the 16 patients who were predicted to have MSD by CS and, therefore, who were candidates for MSE, the combined interpretation of LSs revealed a focal signal in 5 patients (31%) and multifocal signals in 11 (69%) (eFigure 2). Of the 5 focal imaging patients, only 1 (20%) underwent SSE and was cured after excision of the single abnormal parathyroid gland (completely correct LSs), and the other 4 (80%) underwent MSE owing to intraoperative findings as previously described. These 4
patients were cured, where 2 had SSD with completely correct LSs and 2 had MSD with correct with false-negative LSs. Therefore, the 2 patients with completely correct LSs had more extensive surgery than indicated by an accurate focal signal on LSs, and the other 2 with correct with false-negative LSs had appropriate MSE although only a focal signal was seen on LSs. All 11 multifocal imaging patients underwent MSE and were cured (11 with MSD). Nine patients had completely correct LSs and underwent appropriate MSE as indicated by accurate multifocal signals on LSs, and the other 2 had correct with false-negative LSs that required further exploration of nonlocalized sites to achieve cure. Overall, in this group of 16 patients with presumed MSD, there were 3 with SSD (19%) and 13 with MSD (81%). The accuracy of LSs in guiding the surgeon to perform an appropriate and curative exploration occurred in 12 of 16 patients (75%): SSE in 1 and MSE in 11.

In the last group of 15 patients with unknown disease status (SSD or MSD) by CS, the aggregate interpretation of LSs revealed a focal signal in 13 patients (87%) and multifocal signals in 2 (13%) (eFigure 3). Of the 13 focal imaging patients, 10 (77%) underwent SSE, where cure was achieved in 9 (90%) after excision of the single abnormal parathyroid gland (9 with SSD) and 1 (10%) had persistent disease after excision of the localized abnormal parathyroid gland (correct with false-negative LSs). All 9 cured patients had an accurate focal signal on LSs that directed the surgeon to perform a successful SSE. The other 3 patients (23%) who had a focal signal on LSs underwent MSE owing to intraoperative findings, and all were cured (3 with MSD). Therefore, all 3 (2 with correct with false-negative LSs and 1 with completely incorrect LSs) had appropriate MSE due to false-negative signals or a completely incorrect focal signal on LSs. Lastly, in the 2 patients who had multifocal signals on LSs, both underwent MSE and were cured. One patient had MSD with completely correct LSs, and the other had SSD with correct with false-positive LSs. Therefore, the patient with completely correct LSs underwent appropriate MSE as indicated by accurate multifocal signals on LSs, and the other patient with correct with false-positive LSs underwent more extensive, unnecessary exploration due to a false-positive signal on LSs. Overall, there were 10 patients with SSD (67%), 4 patients with MSD (27%), and 1 failure (6%). The accuracy of LSs in guiding the surgeon to perform an appropriate and curative exploration occurred in 10 of 15 patients (67%): SSE in 9 and MSE in 1.

eFigure 1. Outcome of 145 patients who are strongly suspected of having a single remaining abnormal gland. CC indicates completely correct; CI, completely incorrect; FN, false-negative results; FP, false-positive results; LS, localization study; MSD, multiple-site disease; MSE, multiple-site exploration; NE, negative exploration; SSD, single-site disease; and SSE, single-site exploration. *Intraoperative decision to explore multiple sites. Refer to the main article for further explanation.
Candidate for SSE

n=145

131 Focal Signal (90%)

123 SSE (94%)

120 Cure (98%)

6 Cure (75%)

3 SSD: CC LS

3 SSD: Correct w/ FN LS

3 SSD: CC LS

1 MSD: Correct w/ FN LS

2 SSD: CC LS

No Disease: CC LS

14 Multifocal Signal (10%)

14 MSE (100%)

13 Cure (93%)

1 NE (7%)

8 MSE (6%)

6 Cure (75%)

2 NE (25%)

3 SSD: CC LS

3 SSD: Correct w/ FN LS

2 SSD: CC LS

No Disease: CC LS

Aggregate Interpretation of LS

Surgical Approach

Operative Success

Surgically Confirmed Outcome

eFigure 2. Outcome of 16 patients who are strongly suspected of having multiple remaining abnormal glands. CC indicates completely correct; FN, false-negative results; LS, localization study; MSD, multiple-site disease; MSE, multiple-site exploration; SSD, single-site disease; and SSE, single-site exploration. *Intraoperative decision to explore multiple sites. Refer to the main article for further explanation.
eFigure 3. Outcome of 15 patients who could have either a single or multiple remaining abnormal glands. CC indicates completely correct; CI, completely incorrect; FN, false-negative results; FP, false-positive results; LS, localization study; MSD, multiple-site disease; MSE, multiple-site exploration; SSD, single-site disease; and SSE, single-site exploration. *Intraoperative decision to explore multiple sites. Refer to the main article for further explanation.