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Percentage of Prostate Tissue Resected and Detection of Incidental Prostate Cancer during TURP in Men with PSA below 4 ng/mL

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Abstract

Background: Incidental prostate cancer may be detected in transurethral resection of the prostate (TURP) specimens despite prostate-specific antigen (PSA) below 4 ng/mL. Sampling extent may influence pathological detection. **Objectives:** To evaluate the association between the percentage of prostate tissue resected during TURP and detection of incidental prostate cancer (iPCa), including a study-defined composite of International Society of Urological Pathology (ISUP) Grade Group ≥ 2 and/or T1b disease. **Methods:** This retrospective study included 560 consecutive men aged ≥ 50 years who underwent TURP for presumed benign prostatic hyperplasia from January 2020 to December 2025, had PSA < 4 ng/mL and no clearly suspicious digital rectal examination. Percentage resected was calculated as resected tissue weight divided by ultrasound prostate volume ×100. Logistic regression and receiver operating characteristic analyses evaluated associations with pathological detection. **Results:** Incidental cancer was detected in 81/560 men (14.5%). Twenty-nine had Grade Group ≥ 2 disease and seven additional men had Grade Group 1, T1b tumours; 36/560 (6.4%) therefore met the composite definition. Each 10-percentage-point increase in percentage resected was associated with higher adjusted odds of composite-outcome detection (adjusted odds ratio 1.82, 95% confidence interval 1.31 - 2.52; p = 0.0003). The area under the curve was 0.79 (95% confidence interval 0.72 - 0.86). **Conclusions:** A higher percentage resected was associated with greater pathological detection in TURP specimens.

This postoperative ratio reflects sampling extent and requires validation before clinical use.

Keywords

Benign Prostatic Hyperplasia, Incidental Prostate Cancer, Prostate-Specific Antigen, Resection Fraction, Transurethral Resection of the Prostate

1. Introduction

Incidental prostate cancer (iPCa) is adenocarcinoma unexpectedly identified in tissue removed for presumed benign prostatic hyperplasia (BPH). Its detection at TURP has declined in the PSA era but remains clinically relevant, including among men with PSA below the traditional 4 ng/mL threshold. Contemporary TURP series report detection proportions of approximately 3% - 17%, reflecting differences in screening, patient selection and pathological sampling [1]-[3]. Evidence from African settings remains limited, despite constrained access to magnetic resonance imaging and systematic biopsy in many centres.

TURP-detected cancers are classified as T1a when tumour involves ≤5% of resected tissue and T1b when involvement exceeds 5% [4]. Grade Group provides complementary biological information: Grade Group 1 generally represents low-risk disease, whereas Grade Group ≥ 2 is widely used as a marker of clinically significant cancer [4] [5]. T1b Grade Group 1 disease is not biologically equivalent to Grade Group ≥ 2; both components are therefore reported separately in this study.

Reported predictors of iPCa include older age, higher PSA or PSA density, smaller prostate volume, family history and abnormal digital rectal examination [6] [7]. The amount of tissue removed may also influence detection, but absolute resected weight does not account for gland size [6] [8]. The resected-tissue-to-volume ratio may better describe transition-zone sampling. This study evaluated whether percentage resected was associated with detection of any iPCa and a study-defined composite of Grade Group ≥ 2 and/or T1b disease in men with PSA < 4 ng/mL.

2. Methods

2.1. Study Design and Participants

We conducted a retrospective analysis of all consecutive men who underwent TURP for symptomatic benign prostatic hyperplasia at Nkwen Baptist Hospital and Regional Hospital Bamenda, two hospitals in Bamenda, between January 2020 and December 2025. Inclusion criteria were age ≥ 50 years; TURP for moderate-to-severe lower urinary tract symptoms or urinary retention; total PSA < 4.0 ng/mL measured within three months before surgery; and no clearly suspicious DRE finding such as a definite nodule or marked induration. Subtle or equivocal firmness

recorded as a borderline DRE was permitted and analysed separately. Exclusion criteria were known prostate cancer; a previous biopsy positive for cancer; long-term 5-alpha-reductase inhibitor use (>12 months); TURP for a non-BPH indication; or missing preoperative prostate-volume or pathological data. Because percentage resected is only known after TURP, it was treated as a postoperative tissue-sampling metric rather than a preoperative diagnostic test.

Participant selection: Theatre registers were reviewed to identify men who underwent TURP during the study period. Their medical files were retrieved and screened against the eligibility criteria. Ultrasound, laboratory, operative and pathology records from eligible files were reviewed, and variables of interest were extracted using a standardised data-collection form.

2.2. Surgical Technique and Pathology

All TURP procedures were performed using a standard monopolar or bipolar technique by experienced urologists. Immediately after resection, prostate chips were weighed in grams. Preoperative prostate volume was measured by transrectal ultrasonography using the ellipsoid formula (length × width × height × 0.52). Percentage resected was calculated as resected tissue weight (g) divided by preoperative prostate volume (mL), multiplied by 100; the calculation assumes approximate equivalence of 1 mL of prostate tissue to 1 g. This ratio estimates the fraction of the gland sampled during TURP and does not measure completeness of whole-gland cancer assessment.

$$\%\ \text{resected} = \left[\text{resected tissue weight}\ (\text{g}) \big/ \text{preoperative prostate volume}\ (\text{mL})\right] \times 100$$

PSA density was calculated as PSA divided by prostate volume. All TURP chips were fixed in formalin and whole-specimen submitted for histopathological examination. Tumours were graded using the ISUP Grade Group system and staged using the 2017 TNM classification. T1a disease was defined as tumour involving ≤5% of resected tissue and T1b disease as involvement of >5%. Incidental prostate cancer was adenocarcinoma identified in a TURP specimen without a prior diagnosis of prostate cancer. Grade Group ≥ 2 was considered the principal grade-based indicator of clinical significance. A composite endpoint of Grade Group ≥ 2 and/or T1b disease was retained as a secondary, study-defined outcome; its components were also reported separately because T1b Grade Group 1 disease is not biologically equivalent to Grade Group ≥ 2 cancer.

2.3. Statistical Analysis

Continuous variables were summarised as mean ± standard deviation or median (interquartile range), as appropriate. Groups were compared using Student's t test or the Mann-Whitney U test for continuous variables and the chi-square or Fisher exact test for categorical variables. Logistic regression was used to examine factors associated with pathological detection. Percentage resected was evaluated continuously per 10-percentage-point increase; descriptive categories (<20%, 20% - 29.9% and ≥30%) were used for any-iPCa detection. The composite csPCa model included

age, PSA, prostate volume, percentage resected, DRE status and family history. Adjusted odds ratios with 95% confidence intervals were reported. ROC analysis assessed discrimination, with descriptive ≥30% operating points used. Because cut-offs and performance were estimated in the same cohort and no external validation was undertaken, these results were considered exploratory. Statistical tests were two-sided with $p < 0.05$.

Analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

2.4. Ethical Considerations

This study was approved by the Cameroon Baptist Convention Institutional Review Board number 014/2025 of 14 August 2025, with a waiver of informed consent due to the retrospective design and use of de-identified data. The study was conducted in accordance with the ethical standards of the Declaration of Helsinki.

3. Results

3.1. Patient Characteristics

A total of 620 TURP procedures were performed during the study period. After applying the eligibility criteria, 560 men with PSA < 4 ng/mL were included in the analysis. The mean age of the patients was 68.4 ± 6.9 years. The median preoperative PSA was 2.6 ng/mL (IQR 1.8 - 3.3). The mean TRUS-measured prostate volume was 68.3 ± 23.5 mL, and the mean weight of resected prostate tissue was 19.5 ± 9.4 g. The resulting mean percentage of prostate resected was 30.1% ± 10.8%.

Compared with men with BPH only, those with iPCa were older, had higher PSA and PSA density, smaller prostate volume, greater resected weight and a higher percentage resected (Table 1). Borderline DRE findings and family history were also more frequent among men with iPCa, whereas short-term 5-alpha-reductase inhibitor use did not differ significantly.

Table 1. Baseline characteristics of the 560 men undergoing TURP (PSA < 4 ng/mL), stratified by histopathology result (BPH only vs any incidental prostate cancer).

Variable	Overall (n = 560)	BPH only (n = 479)	Any iPCa (n = 81)	p-value
Age (years)	68.4 ± 6.9	67.9 ± 6.7	71.0 ± 7.1	0.0012
PSA (ng/mL)	2.6 (1.8 - 3.3)	2.5 (1.8 - 3.2)	2.9 (2.1 - 3.5)	0.0185
Prostate volume (mL)	68.3 ± 23.5	69.8 ± 23.8	59.7 ± 20.1	0.0009
Resected weight (g)	19.5 ± 9.4	18.6 ± 8.9	24.4 ± 10.2	<0.0001
Percentage resected (%)	30.1 ± 10.8	28.7 ± 10.2	38.2 ± 11.3	<0.0001
PSA density (ng/mL/mL)	0.04 ± 0.01	0.04 ± 0.01	0.05 ± 0.01	0.0036
Abnormal/borderline DRE (%)	15.7	12.5	34.6	<0.0001
Family history of PCa (%)	11.4	10.0	19.8	0.0118
Short-term 5-ARI use (%)	12.9	12.1	17.3	0.1904

Data are: mean ± SD, median (IQR), or % of patients.

3.2. Incidental Prostate Cancer Detection

Incidental prostate cancer was detected in 81/560 men (14.5%). Forty-five of the 81 cancers (55.6%) were Grade Group 1 tumours involving ≤5% of resected tissue (T1a). Twenty-nine patients had Grade Group ≥ 2 disease. Seven additional patients had Grade Group 1 tumours involving >5% of resected tissue (T1b). Thus, 36/560 men (6.4% of the full cohort; 44.4% of iPCa cases) met the study-defined composite endpoint of Grade Group ≥ 2 and/or T1b disease. Grade Group ≥ 2 and T1b status are reported as distinct components because they represent different pathological dimensions.

3.3. Relationship between Percentage Resected and Cancer Detection

Detection of any iPCa increased with the proportion of prostate tissue resected. Incidental cancer was identified in 11/160 men (6.9%) when <20% of the gland was resected, 20/190 (10.5%) when 20% - 29.9% was resected and 50/210 (23.8%) when ≥30% was resected (Table 2). The percentage-resected categories are presented descriptively for any iPCa; the continuous regression model was used for the exploratory composite-outcome analysis.

Table 2. Detection of any incidental prostate cancer according to the percentage of prostate tissue resected during TURP.

% of Prostate Resected	No. of patients (% of cohort)	Any iPCa, n/N (%)
<20%	160 (28.6%)	11/160 (6.9%)
20% - 29.9%	190 (33.9%)	20/190 (10.5%)
≥30%	210 (37.5%)	50/210 (23.8%)
Total cohort	**560 (100%)**	81/560 (14.5%)

In the multivariable model for the study-defined composite outcome (Table 3), each 10-percentage-point increase in percentage resected was associated with higher odds of detection (adjusted OR 1.82, 95% CI 1.31 - 2.52; p = 0.0003) after adjustment for age, PSA, prostate volume, DRE status and family history. Age and an abnormal/borderline DRE were also associated with the composite outcome. These estimates describe associations with pathological detection in the sampled TURP tissue and should not be interpreted as causal effects or as measures of whole-gland cancer prevalence.

Table 3. Multivariable logistic regression for the study-defined composite outcome of ISUP Grade Group ≥ 2 and/or T1b incidental prostate cancer in men with PSA < 4 ng/mL.

Variable	Adjusted OR	95% CI	p-value
Age (per 5-year increase)	1.27	1.02 - 1.59	0.0310
Pre-op PSA (per 1 ng/mL)	1.34	0.95 - 1.88	0.0965
Prostate volume (per 10 mL)	0.88	0.76 - 1.02	0.0952

Continued

% Prostate resected (per +10%)	1.82	1.31 - 2.52	0.0003
Abnormal or borderline DRE (yes)	1.95	1.02 - 3.73	0.0422
Family history of PCa (yes)	1.61	0.82 - 3.16	0.1634

Receiver operating characteristic (ROC) analysis evaluated the discrimination of percentage resected for pathological detection (Table 4). The reported area under the curve (AUC) was 0.73 (95% CI 0.68 - 0.78) for any iPCa and 0.79 (95% CI 0.72 - 0.86) for the study-defined composite outcome. At the descriptive ≥30% threshold, sensitivity and specificity were 61.7% and 66.6% for any iPCa, and 77.8% and 65.3% for the composite outcome. Figure 1 shows the available summary-based ROC operating points for both outcomes. These points do not constitute full empirical ROC curves. The threshold performance is exploratory and requires validation before clinical use.

Table 4. Exploratory ROC performance with descriptive ≥30% thresholds.

Outcome	AUC (95% CI)	Descriptive cut-off	Sensitivity	Specificity
Any iPCa	0.73 (0.68 - 0.78)	≥30%	61.7% (50/81)	66.6% (319/479)
Composite (36/560)	0.79 (0.72 - 0.86)	≥30%	77.8% (28/36)	65.3% (342/524)

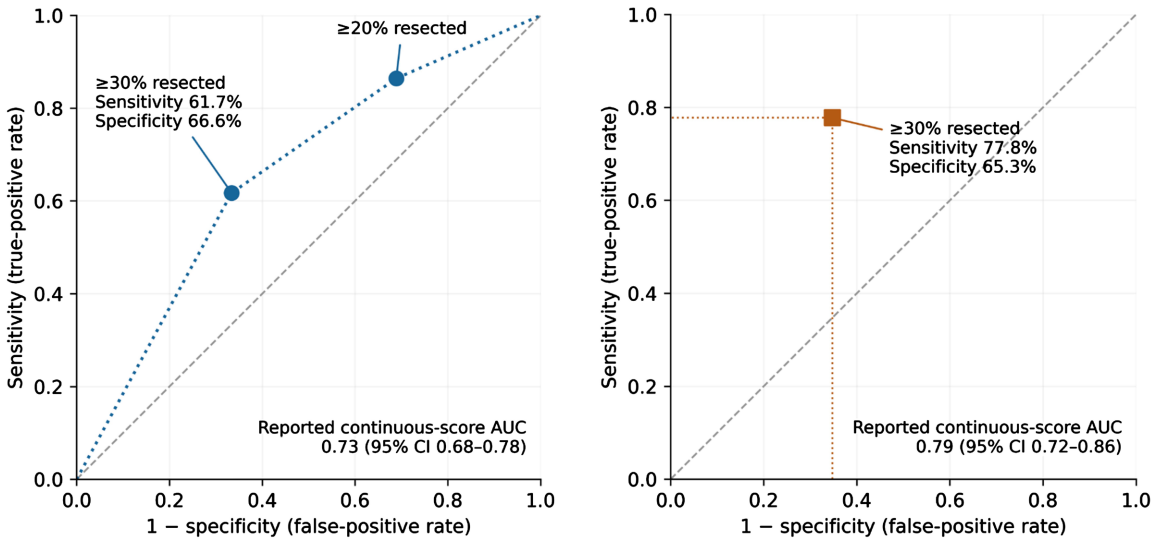


Figure 1. ROC operating points for percentage of prostate tissue resected during TURP. (a) Any incidental prostate cancer (81/560 men), showing the ≥20% and ≥30% resection thresholds calculated from Table 2. (b) The study-defined composite of ISUP Grade Group ≥ 2 and/or T1b disease (36/560 men), showing the ≥30% threshold reported in Table 4. At ≥30%, sensitivity and specificity were 61.7% and 66.6% for any incidental cancer, and 77.8% and 65.3% for the composite outcome. The diagonal dashed line indicates chance discrimination. The dotted connection in panel A interpolates grouped thresholds; the dotted lines in panel B locate the reported operating point. AUC estimates and 95% confidence intervals are quoted from the manuscript and were not calculated from the plotted lines. Full empirical ROC curves require patient-level percentage-resected values and outcome data. AUC, area under the receiver operating characteristic curve; CI, confidence interval; ISUP, International Society of Urological Pathology; TURP, transurethral resection of the prostate.

4. Discussion

In this selected surgical cohort, iPCa was detected in 14.5% of men and 6.4% met the study-defined composite of Grade Group ≥ 2 and/or T1b disease. These are detection proportions, not population incidence estimates. They demonstrate that PSA below 4 ng/mL does not exclude clinically relevant pathological findings and support histological assessment of TURP tissue, particularly where preoperative MRI and biopsy access is limited.

A higher resected-tissue-to-volume ratio was associated with greater cancer detection. The most plausible explanation is sampling: examining a larger fraction of the transition zone increases the opportunity to encounter an occult focus. Percentage resected is consequently a postoperative sampling metric, not a measure of biological cancer risk. The association does not show that extensive resection causes cancer or that men with a low resection fraction have a lower prevalence of disease.

TURP does not systematically sample the peripheral zone, where most prostate cancers arise. A high percentage resected cannot therefore exclude residual clinically significant disease, and a low percentage alone does not mandate imaging or biopsy. Post-TURP evaluation should integrate Grade Group, T1a/T1b classification, postoperative PSA, life expectancy, comorbidity, MRI findings where available and patient preference [2] [4].

The findings are broadly consistent with contemporary evidence that most incidental tumours are low grade and may be managed conservatively in appropriately selected patients [5] [9]-[11]. Nevertheless, 29 men in this cohort had Grade Group ≥ 2 disease and seven additional men had Grade Group 1, T1b tumours. These outcomes should not be considered interchangeable: grade reflects tumour biology, whereas T1b reflects the proportion of sampled tissue involved. Treatment decisions cannot be inferred from either measure alone.

The study adds evidence from a setting where occult prostate cancer after BPH surgery remains underreported. Percentage resected is inexpensive and routinely obtainable and may help describe the adequacy of transition-zone sampling. Its clinical value, however, depends on validation against MRI, confirmatory biopsy, whole-gland pathology and oncological outcomes.

Strengths and limitations: Strengths include consecutive case inclusion, restriction to men with PSA < 4 ng/mL and use of a simple sampling ratio. Limitations include the retrospective two-hospital design in Bamenda, possible selection and information bias, lack of systematic MRI, absence of whole-gland verification and no long-term outcomes. Percentage resected is mathematically related to prostate volume, potentially affecting regression estimates. The composite outcome combines Grade Group ≥ 2 with T1b status, although T1b depends on sampled-tissue involvement. The model included six covariates but only 36 events and may be overfitted. Surgeon and operative-technique effects were not modelled. ROC estimates remain unvalidated, and the small number of composite events limits the reliability of adjusted estimates.

5. Conclusions

Among men undergoing TURP for presumed BPH with PSA < 4 ng/mL, iPCa was detected in 14.5% and 6.4% met the study-defined composite of Grade Group ≥ 2 and/or T1b disease. A higher percentage resected was associated with greater pathological detection. This ratio should be interpreted as a postoperative measure of sampling extent, not a preoperative diagnostic test or evidence that residual significant disease is absent. Prospective multicentre validation using separate Grade Group and T-stage outcomes is required.

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Conflicts of Interest

The authors declare that no conflict of interest exists.

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