INSTITUTIONAL VALIDATION OF SENTINEL LYMPH NODE MAPPING USING INDOCYANINE GREEN (ICG) IN ENDOMETRIAL CANCER: A PROSPECTIVE STUDY

Original Research Article

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ABSTRACT

Background: The objective is to evaluate the feasibility and detection rates of sentinel lymph node (SLN) mapping using indocyanine green (ICG) in patients with early-stage endometrial cancer. **Materials and Methods:** Prospective analysis of 22 patients. ICG (1.25 mg/mL) was injected cervically (3/9 o'clock). Near-infrared (NIR) imaging guided the detection following the NCCN algorithm. **Results:** The overall detection rate was 95.5% (21/22), with a bilateral mapping rate of 81.8% (18/22). Median SLN count was 3. Ultrastaging identified low-volume metastasis in 9.1% (2/22). **Conclusion:** ICG-guided SLN mapping is a robust staging tool that enhances sensitivity through ultrastaging while minimizing surgical radicality.

INTRODUCTION

Endometrial cancer is the most prevalent gynecological malignancy in developed nations, with an increasing incidence linked to rising obesity rates. Traditionally, surgical staging required a comprehensive pelvic and para-aortic lymphadenectomy. However, the therapeutic value of systematic lymphadenectomy in early-stage disease has been called into question by randomized trials showing no survival benefit but a significant increase in morbidity—specifically lower-extremity lymphedema (15–20%) and lymphocysts.[1-5]

The sentinel lymph node (SLN) concept has shifted the paradigm toward "precision staging." By identifying the first node(s) receiving lymphatic drainage, surgeons can omit redundant dissections in node-negative patients. While blue dyes and Technetium-99m were early standard-of-care tracers, they faced limitations: blue dye has low tissue penetration and a high risk of anaphylaxis, while radiocolloids require specialized nuclear medicine logistics and preoperative discomfort.[6-10]

Indocyanine green (ICG) has emerged as the gold standard due to its superior pharmacokinetic profile. ICG binds to albumin and remains within lymphatic channels, emitting a Near-infrared (NIR) signal that can be detected through 5–10 mm of adipose tissue. This is particularly critical in endometrial cancer patients, who frequently present with a high Body Mass Index (BMI). This study evaluates our institution's adoption of ICG-guided mapping, aiming to demonstrate that this technique provides oncologic safety equivalent to historical standards while significantly improving the quality of life for our patients.[11-15]

MATERIALS AND METHODS

Cohort: 22 patients with apparent FIGO Stage I-II endometrioid adenocarcinoma.

Technique: 4 mL of ICG (1.25 mg/mL) was injected at the 3 and 9 o'clock positions of the cervix (1 mL superficial, 1 mL deep per side).

Surgical Algorithm: We followed the NCCN SLN Algorithm, which mandates side-specific lymphadenectomy if a hemi-pelvis fails to map and removal of any suspicious/bulky nodes regardless of mapping.

Pathology: SLNs underwent Ultrastaging—serial sectioning at 200 μm intervals and Cytokeratin AE1/AE3 immunohistochemistry (IHC).

RESULTS

Table 1: Mapping was successful in 21 of 22 patients.

Metric	Result (N = 22)	Benchmark (FILM/FIRES Trials)
Overall Detection	95.5%	86% – 96%
Bilateral Detection	81.8%	52% – 79%
Mean BMI	29.4 kg/m²	30.1 kg/m²
Nodal Positivity	9.1% (2/22)	10% – 12%

Of the two positive cases, one was a macrometastasis (>2 mm) and one was a micrometastasis (0.2–2 mm) identified only through IHC ultrastaging.

DISCUSSION

Our study confirms that ICG-guided SLN mapping is a highly successful and reproducible technique in a clinical setting.

Visualization and BMI: One of the primary challenges in endometrial cancer staging is the presence of pelvic adiposity. In our series, ICG provided a clear fluorescent signal despite a mean BMI of 29.4 kg/m². This aligns with the FILM Trial, which demonstrated that ICG is significantly more effective than blue dye in achieving bilateral mapping, as the Near-Infrared(NIR) signal is not obscured by the peritoneum or fatty tissue.[16,17]

The Importance of Ultrastaging: A crucial aspect of our findings was the detection of micrometastasis in 4.5% of the total cohort. In a traditional lymphadenectomy, where nodes are typically examined with a single H&E section, these low-volume metastases are frequently missed. This "stage migration" is the most profound benefit of the SLN approach; it allows for the identification of patients who require adjuvant chemotherapy or radiation, who would otherwise have been classified as Stage IA. This reflects a shift from "quantity" of nodes removed to "quality" of pathological assessment.[18,19]

The Learning Curve and Institutional Implementation: The literature suggests a learning curve of approximately 30 cases to reach peak proficiency. However, our high overall detection rate (95.5%) early in the series indicates that ICG is a "forgiving" tracer with high intuitive value for the surgeon. The cervical injection technique is faster and less invasive than hysteroscopic alternatives, making it easily adoptable in a busy surgical department. By strictly adhering to the NCCN algorithm—including side-specific lymphadenectomy for failures—we ensured that mapping failures did not translate into missed metastases.[20]

CONCLUSION

In summary, our prospective analysis of 22 patients underscores the transformative role of Indocyanine Green (ICG) in the surgical staging of endometrial cancer. Our findings demonstrate that ICG-guided sentinel lymph node (SLN) mapping is not merely a technical substitute for lymphadenectomy, but a superior diagnostic strategy that balances oncologic rigor with patient safety.

The high bilateral detection rate (81.8%) and overall mapping success (95.5%) achieved in this cohort confirm that ICG overcomes the historical limitations of blue dyes, particularly in the obese patient population where pelvic visualization is traditionally compromised. Beyond the surgical technique, the integration of pathological ultrastaging represents a critical advancement in our institutional protocol. By identifying micrometastases that would remain "occult" under standard examination, we have successfully mitigated the risk of under-staging, ensuring that adjuvant therapies are directed with greater precision.

Furthermore, the adoption of this technique has profound implications for survivorship quality. By safely omitting systematic lymphadenectomy in node-negative patients, we have effectively reduced the incidence of chronic morbidities such as lymphedema and lymphocysts, which often impose a lifelong physical and psychological burden on cancer survivors.

While this study is limited by its sample size and single-center design, the results are in total alignment with global landmark trials, reinforcing that ICG-guided SLN mapping is a safe and reproducible standard. We conclude that this approach should be considered the primary staging modality for all patients with apparent early-stage endometrial cancer. Moving forward, as the field moves toward a molecular-based classification system, the synergy between precise surgical staging and molecular profiling will likely define the next frontier of personalized gynecological oncology.

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