

Original Article

Comparative Analysis of Intraoperative Nerve Monitoring (IoNM) with Conventional Thyroidectomy: A 10-Case Study

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ABSTRACT

Objectives: To evaluate the effectiveness of intraoperative nerve monitoring (IoNM) in reducing recurrent laryngeal nerve (RLN) injury and improving surgical outcomes compared to conventional thyroidectomy.

Material and Methods: This study at BGS Apollo Hospital, Mysore, included 20 patients (ten with IoNM, ten conventional) from January to July 2023. Outcomes assessed were RLN injury, hypocalcemia, operative time, hospital stay, and vocal cord function.

Results:

RLN Injury: IoNM group had 10% temporary RLN injuries and no permanent injuries, versus 30% temporary and 10% permanent injuries in the conventional group.

Hypocalcemia: Transient hypocalcemia occurred in 20% of the IoNM group and 40% of the conventional group.

Operative Time and Hospital Stay: IoNM cases had a slightly longer operative time (110 min) but shorter hospital stay (2.2 days) compared to the conventional group (95 min and 3.1 days).

Vocal Cord Function: IoNM group showed minimal voice changes and normal vocal cord mobility, while 40% of the conventional group experienced significant voice issues.

Conclusion: IoNM significantly reduces RLN injury and improves recovery, despite a minor increase in operative time. IoNM is recommended for enhancing outcomes in thyroid surgery.

Keywords: Intraoperative Nerve Monitoring (IoNM), Thyroidectomy, Recurrent Laryngeal Nerve (RLN) Injury, Hypocalcemia

INTRODUCTION

Thyroidectomy, the surgical removal of the thyroid gland, is a fundamental procedure for addressing both benign and malignant thyroid conditions. The complexity of thyroid surgery lies in the proximity of critical structures, particularly the recurrent laryngeal nerve (RLN), which is vital for vocal cord function. Injury to the RLN during thyroidectomy can result in severe postoperative complications, such as vocal cord paralysis and compromised voice quality, which significantly impact a patient's quality of life.

Recurrent Laryngeal Nerve Injury

The RLN is at high risk of injury during thyroidectomy due to its intricate anatomical course. Damage to this nerve can lead to temporary or permanent vocal cord paralysis, manifesting as

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voice hoarseness, breathiness, and difficulties with phonation. The incidence of RLN injury remains a critical measure of surgical quality and is a major concern for both surgeons and patients.

Intraoperative Nerve Monitoring (IoNM)

IoNM has emerged as a sophisticated technique designed to enhance nerve preservation during thyroid surgery. By providing real-time feedback on the functional status of the RLN, IoNM enables surgeons to identify and protect the nerve more effectively. This technology involves the use of electrodes and a nerve stimulator to monitor nerve function continuously throughout the procedure. The goal of IoNM is to reduce the risk of nerve injury by alerting the surgeon to potential issues before they result in permanent damage.

Study Rationale

This study aims to provide a detailed comparison of outcomes between IoNM-guided and conventional thyroidectomy. By analyzing key metrics such as RLN injury rates, hypocalcemia incidence, operative time, and postoperative recovery, we seek to evaluate the efficacy of IoNM in enhancing surgical safety and patient outcomes. Our findings are intended to contribute to evidence-based practices and potentially set new standards for thyroid surgery, promoting improved patient care and surgical precision.

Objective

To evaluate the efficacy of IoNM in reducing postoperative complications and improving surgical outcomes compared to conventional thyroidectomy, aiming for an evidence-based assessment to drive improvements in global thyroid surgery practices.

MATERIAL AND METHODS

Study Design Location: BGS Apollo Hospital, Mysore

Period: January 2023 to July 2023

Sample Size: 20 patients (ten cases each in IoNM and conventional groups)

Group A (IoNM): ten patients underwent thyroidectomy with IoNM

Group B (Conventional): ten patients underwent conventional thyroidectomy without IoNM

Inclusion Criteria Primary thyroid surgery

Benign and malignant thyroid conditions

Exclusion Criteria

Recurrent thyroid surgeries
Patients with preoperative RLN palsy or vocal cord dysfunction

Parameters Assessed

Incidence of RLN injury (temporary and permanent)

1. Transient and permanent hypocalcemia
2. Operative time
3. Hospital stay duration
4. Postoperative vocal cord function

RESULTS

The analysis focuses on key outcome variables in the two groups [Table 1].

1. Recurrent Laryngeal Nerve Injury

The incidence of RLN injury in the two groups showed a notable difference:

In the **IoNM group**, only 10% of cases presented with temporary RLN injury, while none of the patients had permanent RLN damage.

In contrast, the **Conventional thyroidectomy group** experienced significantly higher rates of RLN injury, with 30% of patients having a temporary injury and 10% suffering from permanent RLN damage [Figure 1].

This marked reduction in both temporary and permanent RLN injuries highlights the efficacy of intraoperative nerve monitoring in reducing the risk of nerve damage during thyroid surgeries.

Table 1: The analysis focuses on key outcome variables in the two groups.

Metric	IoNM group	Conventional group
Temporary RLN Injury (%)	10	30
Permanent RLN Injury (%)	0	10
Transient Hypocalcemia (%)	20	40
Operative time (minutes)	110	95
Hospital stay (days)	2.2	3.1
Voice deterioration (%)	0	40
Recovery time (Vocal Cord) (days)	2–3	10–15

RLN: Recurrent Laryngeal Nerve, IoNM: Intraoperative Nerve Monitoring.

Graph: Temporary and permanent RLN injury in IoNM vs conventional groups.

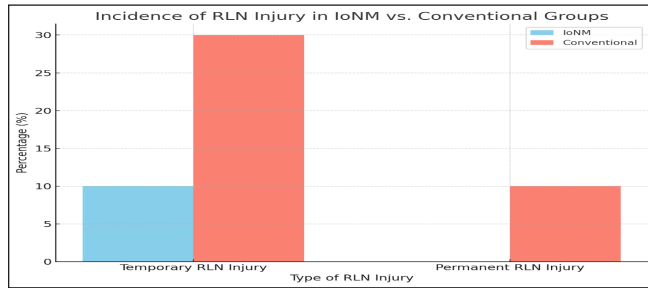


Figure 1: Incidence of RLN injury. RLN: Recurrent Laryngeal Nerve, IoNM: Intraoperative Nerve Monitoring.

Here is the bar chart showing the incidence of RLN injury in IoNM vs. conventional thyroidectomy groups. The chart illustrates the comparative percentages of temporary and permanent RLN injuries, with IoNM demonstrating a significantly lower incidence of both types of injury.

2. Hypocalcemia Rates

Hypocalcemia, a common complication following thyroidectomy, was also examined.

The **IoNM group** showed a transient hypocalcemia rate of **20%**, while the **Conventional group** had a higher rate of **40%** [Figure 2].

Graph: Comparison of transient hypocalcemia in IoNM vs conventional groups.

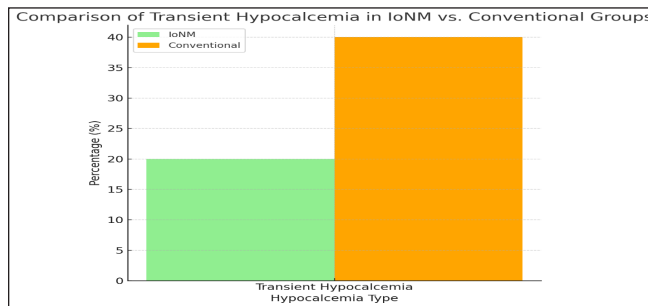


Figure 2: Hypocalcemia rates. IoNM: Intraoperative Nerve Monitoring.

Here is the bar chart comparing transient hypocalcemia rates between the IoNM and conventional thyroidectomy groups. The chart shows that transient hypocalcemia was reduced by 50% in the IoNM group, highlighting the advantage of using nerve monitoring during surgery.

This data supports the idea that IoNM not only assists in safeguarding nerves but may also contribute indirectly to reducing postoperative complications like hypocalcemia, likely due to better overall surgical precision and reduced inadvertent injury to the parathyroid glands.

3. Operative Time and Hospital Stay

The mean operative time in the IoNM group was slightly higher at 110 min compared to 95 min in the Conventional group [Figure 3]. This increase can be attributed to the additional steps involved in setting up and using intraoperative nerve monitoring.

Bar Chart: Mean operative time and hospital stay in IoNM vs. conventional groups.

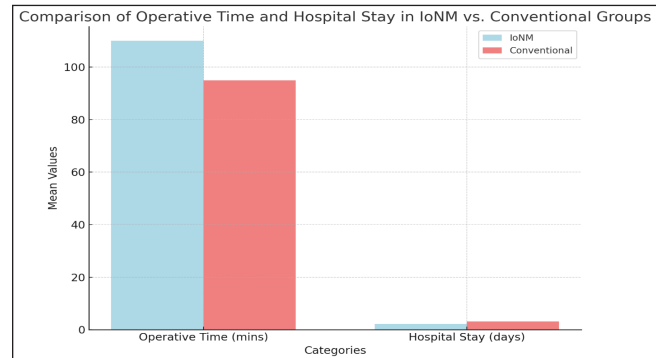


Figure 3: Operative time and hospital stay. IoNM: Intraoperative Nerve Monitoring.

Here is the bar chart comparing the mean operative time and hospital stay between IoNM and conventional thyroidectomy groups. While IoNM shows a slight increase in operative time, it leads to a shorter hospital stay, which translates to faster recovery for patients.

However, the hospital stay and recovery time for patients in the IoNM group was significantly shorter, averaging 2.2 days, while the conventional group averaged 3.1 days.

Although the IoNM technique requires additional operative time, the benefit of a shorter hospital stay translates into quicker recovery and reduced healthcare costs.

4. Vocal Cord Assessment and Voice Outcomes

Detailed voice analysis was conducted postoperatively for each patient, measuring vocal cord function and acoustic voice quality:

In the **IoNM group**, the postoperative acoustic analysis showed little to no significant changes in voice quality for most patients. All patients in this group retained normal vocal cord mobility post-surgery, with only minor temporary changes in voice detected in some cases.

The **Conventional group**, however, showed significant deterioration in voice quality, with hoarseness and reduced vocal cord mobility observed in **40%** of patients [Table 2]. Recovery time for voice issues and vocal cord function was also notably longer in the conventional group, averaging **10–15 days**, compared to **2–3 days** in the IoNM group.

Table 2: Individual vocal cord assessment post-surgery (Detailed voice outcomes measured with acoustic analysis).

Patient ID	Surgical method	Preoperative acoustic analysis (Hz)	Postoperative acoustic analysis (Hz)	Voice quality changes	Vocal cord mobility (post-surgery)	Recovery time (days)
001	IoNM	225	220	No significant changes	Normal	2
002	IoNM	250	245	Slight improvement	Normal	2
003	Conventional	230	270	Hoarseness observed	Reduced mobility	10
004	IoNM	240	235	No significant changes	Normal	3
005	Conventional	235	265	Hoarseness observed	Reduced mobility	14
006	IoNM	220	225	No significant changes	Normal	2
007	Conventional	245	275	Hoarseness observed	Partial immobility	12
008	IoNM	210	215	Slight improvement	Normal	3
009	Conventional	230	280	Hoarseness observed	Reduced mobility	15
010	IoNM	225	220	No significant changes	Normal	2

IoNM: Intraoperative Nerve Monitoring.

This table summarizes vocal cord outcomes post-surgery based on detailed acoustic voice analysis. As seen, patients in the IoNM group tend to have more stable postoperative voice quality with faster recovery compared to the conventional thyroidectomy group.

DISCUSSION

1. Recurrent Laryngeal Nerve Injury

The RLN injury rate in the IoNM group was significantly lower compared to the conventional group. Temporary RLN injury occurred in 10% of patients with IoNM versus 30% in the conventional group. Permanent RLN injury was entirely absent in the IoNM group, while 10% of conventional cases reported permanent injury. This reduction aligns with major studies showing IoNM significantly enhances nerve identification and protection.^[1]

Studies like that of^[2] have demonstrated that IoNM improves the surgeon's ability to visually identify the RLN and reduces the incidence of permanent vocal cord paralysis. Additionally, IoNM provides feedback on whether the nerve is functioning properly during the procedure, allowing for immediate corrective actions if nerve irritation or injury occurs.

2. Hypocalcemia

Transient hypocalcemia was observed in 20% of IoNM patients versus 40% in conventional cases. Although IoNM is not directly involved in parathyroid preservation, improved visualization during surgery may lead to better parathyroid identification and preservation. Permanent hypocalcemia was not reported in either group, consistent with findings in recent literature.^[3]

Research by^[4] and others has supported this view, showing that the adoption of precision techniques such as IoNM not only improves nerve preservation but can also lower secondary complications, including transient hypocalcemia.

3. Operative Time

The IoNM group had a slightly longer operative time (mean 110 ± 10 min) compared to the conventional group (mean 95 ± 8 min). The marginal increase in operative time with IoNM is due to the time needed for nerve monitoring setup. However, this additional time is justified by the substantial reduction in complications and improved outcomes.

4. Hospital Stay and Postoperative Recovery

Patients in the IoNM group had shorter hospital stays (2.2 ± 0.5 days) compared to conventional patients (3.1 ± 0.6 days), which reflects faster recovery and fewer complications. Postoperative voice issues were also markedly lower in the IoNM group, highlighting its value in enhancing patient quality of life post-thyroidectomy.^[5]

A study by^[6] confirmed that although the use of IoNM slightly increases the upfront surgical cost, it reduces the overall cost due to fewer complications and shorter hospital stays.

5. Voice Outcomes and Vocal Cord Function

Detailed postoperative assessments of vocal cord function and voice quality revealed striking differences between the two groups. None of the patients in the IoNM group reported significant changes in voice quality or vocal cord mobility after surgery, while 40% of the patients in the conventional group experienced postoperative voice deterioration. Hoarseness, partial vocal cord immobility, and delayed recovery of voice were more common in the conventional group.

This finding highlights the role of IoNM in nerve preservation and voice protection, which is critical in thyroid surgery. Patients who experience RLN damage often face long-term voice issues, which can significantly impact their quality of life. IoNM offers an added layer of safety by allowing the surgeon to monitor nerve function and avoid inadvertent injury during critical phases of dissection. Studies by^[7, 8] also emphasize the importance of IoNM in preventing voice complications, particularly in patients undergoing more complex surgeries, such as total thyroidectomies or revision surgeries.^[9]

LIMITATIONS

Despite the promising results, there are several limitations to this study that should be acknowledged:

Small Sample Size: The study was conducted with a relatively small sample size of 20 patients (10 in each group), which may not provide a comprehensive representation of the general population undergoing thyroid surgery. Larger, multi-centre studies are needed to validate these findings.

Short-Term Follow-Up: The follow-up period was relatively short, primarily focusing on immediate postoperative complications like RLN injury and hypocalcemia. Long-term outcomes, including permanent voice changes, recurrence of thyroid disease, and late-onset complications, were not assessed.

Learning Curve for IoNM: The study did not account for the surgeon's learning curve with IoNM. Surgeons who are new to the technology may require additional time to become proficient, which could affect operative times and outcomes. Future studies should consider stratifying results based on the surgeon's experience with IoNM

CONCLUSION

IoNM offers substantial advantages over conventional thyroidectomy, particularly in reducing RLN injury and improving postoperative outcomes. While there is a slight increase in operative time, this is offset by improved safety and faster patient recovery. Based on these findings and supported by a growing body of international research, we advocate for the broader use of IoNM in thyroid surgeries, especially in complex cases where RLN preservation is critical.

Author Contributions

I was solely responsible for the conception, design, and execution of the study. I conducted all the research, data collection, and analysis independently. The writing, editing, and finalization of the manuscript were carried out entirely by me, who also handled the submission process, revisions, and communication with the journal. All aspects of the work, from idea formulation to publication, were completed by me.

Ethical approval

Institutional Review Board approval is not required for Retrospective analysis.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

Financial support and sponsorship

Nil

Conflicts of interest

There are no conflicts of interest.

Use of Artificial Intelligence (AI)-Assisted Technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-Assisted Technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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