Comparative Study of Transcutaneous Electrical Nerve Stimulation (TENS) versus Sterile Water Injection (SWI) for Labour Analgesia in a Tertiary Care Hospital

Abstract

Background: Labour pain is severe and impacts maternal-fetal health. This study compares non-pharmacological TENS, which blocks pain via the Gate Control Theory, and Sterile Water Injection (SWI), which utilizes diffuse noxious inhibitory control. Both offer safe, effective analgesia, reducing VAS scores and enhancing maternal satisfaction without affecting labour duration or neonatal outcomes.

Aims: This study compares the efficacy of Transcutaneous Electrical Nerve Stimulation (TENS) and intradermal sterile water injection (SWI) in reducing labour pain and to assess feto-maternal outcomes and maternal satisfaction.

Methodology:A prospective interventional study was conducted among 125 term pregnant women aged 21-35 years scheduled for normal vaginal delivery. Participants were divided into Group T (TENS), Group S (Sterile Water Injection), and Group C (Control). Pain was assessed using the Visual Analogue Scale (VAS) at baseline and intervals up to 360 minutes.

Results:TENS and SWI significantly reduced pain compared to the control group ($p < 0.05$). TENS showed a more rapid and sustained reduction in pain intensity than SWI. Maternal satisfaction was highest in the TENS group (4.54 ± 1.19), followed by SWI (3.82 ± 1.2), and lowest in the control group (2.9 ± 1.3). No significant differences were found in the duration of labour stages or neonatal outcomes (APGAR scores).

Conclusion: Both TENS and SWI are effective, safe, non-pharmacological methods for labour analgesia, with TENS providing superior maternal satisfaction and more sustained pain relief.

Keywords: Labour Analgesia, Transcutaneous Electrical Nerve Stimulation (TENS), Sterile Water Injection (SWI), Visual Analogue Scale (VAS), Maternal Satisfaction, Non-pharmacological pain management, Michaeli's Rhomboid.

1.Introduction:

The pain associated with labour is one of the most intense forms of human pain. As a subjective and multifaceted experience, it necessitates an individualized approach to management. Effective labour analgesia is vital for both maternal and fetal well-being; severe pain and stress trigger the release of circulating catecholamines, leading to uterine

vasoconstriction and reduced placental perfusion. These processes can result in fetal hypoxia and metabolic acidosis. Furthermore, pain-induced hyperventilation causes maternal respiratory alkalosis, further emphasizing the clinical necessity of pain relief.

While pharmacological methods are effective, they may cause a loss of essential feedback, potentially prolonging labour or increasing the need for intervention. Many pharmacological agents also limit maternal motility and autonomy, which can be distressing. Consequently, there has been a significant shift toward non-pharmacological techniques. This trend is driven by an emphasis on patient-centered, holistic care that empowers women to actively engage in the birth experience with minimal adverse effects.

Among these, Transcutaneous Electrical Nerve Stimulation (TENS) and Sterile Water Injection (SWI) have emerged as accessible, non-invasive options. TENS utilizes pulsed electrical currents delivered across the skin to activate underlying nerves. It is believed to operate via the "Gate Control Theory" and the release of endogenous opioids, providing maximal analgesia through non-painful electrical paraesthesia.

In contrast, Sterile Water Injections function through "diffuse noxious inhibitory control." Intradermal injections in the lower back create a brief, painful stimulus that triggers the brain to release its internal supply of endorphins, thereby reducing the perception of labour pain. This study aims to investigate the clinical application and effectiveness of TENS versus SWI to provide obstetricians with evidence-based data to guide intrapartum care.

2.Materials & Methods:

A prospective interventional study was conducted among 125 term pregnant women aged 21-35 years scheduled for normal vaginal delivery from December 2023 to March 2025 in Department of Obstetrics & Gynaecology, Pt. J.N.M. Medical College and Dr. BRAM Hospital, Raipur (C.G.). Participants were divided into Group T (TENS), Group S (Sterile Water Injection), and Group C (Control).

2.1 Methodology:

Group T: Transcutaneous Electrical Nerve Stimulation (TENS)

- Placement: Upper electrodes placed bilaterally over the T10–L1 paravertebral region (~2 cm lateral to the spinous processes). Lower electrodes placed bilaterally over the S2–S4 sacral foramina.
- Settings: The device was set to a frequency of 100 Hz for a minimum of 30 minutes.
- Reapplication: Based on maternal request.

Group S: Sterile Water Injection (SWI)

- Procedure: Four intradermal injections of 0.5 mL sterile water each.
- Anatomical Site: Administered over the Michaelis rhomboid.
- Injection Points: Two over the posterior superior iliac spines (PSIS) and two placed 1 cm medial and 1–2 cm inferior to the PSIS.

Group C: Control Group

- This group received standard care without the specific analgesic interventions used in the other groups to serve as a baseline comparator.

2.2 Outcome:

- Pain Relief: Assessed using the Visual Analogue Scale (VAS) score reduction.
- Labour Progress: Duration of the first, second, and third stages of labour was monitored.
- Maternal Satisfaction: Evaluated using a 7-point Likert Scale.
- Feto-Maternal Outcomes: Includes neonatal APGAR scores at 5 minutes and monitoring for side effects such as nausea, syncope, or skin reactions (allergy/tingling/pain) at the site of intervention.

2.3 Statistical Analysis:

- Sample size was estimated with 95% confidence limits and 80% power to detect at least a 10% difference in effect proportions.
- Data was analyzed using appropriate statistical tests (e.g., P-values) to determine significance in intergroup comparisons.

3.Results:

3.1 Demographic Profile:

Characteristics	Group T (TENS) (n=50)	Group S (SWI) (n=50)	Group C (Control) (n=25)	P-Value
Mean Age (years)	26.34 ± 3.21	26.52 ± 3.11	25.96 ± 2.98	0.79
Mean BMI (kg/m^2)	27.32 ± 3.17	28.1 ± 3.29	27.72 ± 3.58	0.19
Primigravida (%)	15 (30.0%)	16 (32.0%)	09 (36.0%)	0.38
Multigravida (%)	35 (70.0%)	34 (68.0%)	16 (64.0%)	0.38

3.2 Labour Analgesia Efficacy (VAS Scores):

Interval	Group T (TENS)	Group S (SWI)	Group C (Control)	P-value (T vs S)
Baseline	9.96 ± 0.19	9.88 ± 0.43	9.65 ± 0.25	0.89
15 minutes	8.6 ± 0.49	9.52 ± 0.86	9.5 ± 0.51	<0.001
120 minutes	7.5 ± 0.5	8.74 ± 0.48	9.75 ± 0.44	<0.001
240 minutes	6.34 ± 0.55	8.02 ± 0.24	9.95 ± 0.22	<0.001
360 minutes	6.08 ± 0.39	7.78 ± 0.46	9.7 ± 0.47	<0.001

3.3Distribution of Mode of Delivery:

Mode of Delivery	Group T (TENS) (n=50)	Group S (SWI) (n=50)	Group C (Control) (n=25)	P-Value
Vaginal Delivery	38 (76.0%)	36 (72.0%)	17 (68.0%)	0.38
Instrumental (AVD)	06 (12.0%)	06 (12.0%)	04 (16.0%)	0.92
LSCS	06 (12.0%)	08 (16.0%)	04 (16.0%)	0.84

3.4 Distribution of mean Maternal satisfaction:

	Group T (TENS) (n=50)	Group S (SWI) (n=50)	Group C (Control) (n=25)	P-value (T vs S)	P-value (T vs C)	P-value (S vs C)
Maternal Satisfaction Score	4.54 ± 1.19	3.82 ± 1.2	2.9 ± 1.3	0.03	0.002	0.04

3.5Comparison of Neonatal Outcomes:

Neonatal Parameter	Group T (TENS) (n=50)	Group S (SWI) (n=50)	Group C (Control) (n=25)	P-Value
Mean APGAR Score (at 5 min)	9.48 ± 0.54	9.44 ± 0.64	9.52 ± 0.68	0.67
Neonatal Death	0 (0%)	0 (0%)	0 (0%)	0.98

Discussion:

Labour pain, one of the most intense human experiences, significantly affects both the mother and fetus. In the mother, it activates the sympathetic nervous system, causing tachycardia, hypertension, and hyperventilation, which may lead to respiratory alkalosis and reduced uterine blood flow. This can prolong labour, impair cooperation, and cause emotional trauma and exhaustion. For the fetus, decreased placental perfusion and maternal hyperventilation can result in fetal hypoxia, while prolonged labour increases the risk of birth trauma and emergency interventions.

Labour analgesia is a basic right and an essential part of respectful maternity care. Women should be given options and supported to make informed choices that align with their preferences. It is vital for the safety, comfort, and emotional well-being of both mother and baby & has the following importance:

- **Improves Maternal Comfort and Satisfaction**: allows the mother to remain calm, reduce fear and anxiety, and improve overall experience.
- **Enhances Physiological Outcomes:** pain relief reduces stress response, improves blood flow to uterus, and promotes effective contractions.
- **Reduces Maternal and Fetal Morbidity:** prevents exhaustion, hypertension, and fetal distress by maintaining stable maternal physiology.
- **Encourages Active Participation:** with effective analgesia, mothers can be more active in decision-making and delivery efforts.

Effective pain relief during labour is crucial for maternal well-being, satisfaction, and positive birth outcomes. A balanced approach using pharmacological and non-pharmacological methods ensures optimal outcomes.

Pharmacological analgesia remains the mainstay of labour pain management due to its proven efficacy. Systemic opioids such as pethidine, fentanyl, and tramadol are widely used for their ease of administration and moderate pain relief. They help reduce anxiety and discomfort during labour, especially in early stages. However, they come with maternal side effects like nausea, vomiting, sedation, and respiratory depression. These drugs also cross the placenta, potentially causing neonatal respiratory depression, decreased alertness, and impaired initiation of breastfeeding.

Inhalational agents, such as nitrous oxide, offer the benefit of rapid onset, self-administration, and minimal effect on the fetus. They are particularly useful in the early or transitional phases of labour. Yet, maternal side effects like dizziness, nausea, and euphoria may reduce the mother's ability to cooperate during labour, and in rare cases, can cause loss of consciousness.

Regional analgesia, particularly epidural anaesthesia, provides the most effective pain relief throughout labour indicated by significant reduction in VAS score. It enables mothers to remain alert and actively participate in childbirth. Nevertheless, it is not available in many centres due to the paucity of anaesthesiologists & it is associated with risks such as maternal hypotension, urinary retention, motor block, and, rarely, neurological complications. If maternal hypotension occurs, it can lead to transient fetal bradycardia, it is an invasive method, hence, is not readily opted by patients in labour.

While pharmacological methods provide significant benefits, the potential for maternal and fetal side effects necessitates a balanced approach. This underscores the importance of non-pharmacological analgesia such as Transcutaneous Electrical Nerve Stimulation (TENS) and sterile water injections. These techniques are safe, non-invasive, and free of systemic side effects. They promote maternal involvement, reduce anxiety, and can be especially valuable when used in combination with pharmacological methods or when medication is contraindicated. The debut of non-pharmacological analgesia in labour represents a significant advancement in obstetric care—offering women effective, accessible, and empowering options for pain relief while supporting favourable maternal and neonatal outcomes.

Limitations:

1. A small sample size can limit generalizability of the findings to a larger population.

2. VAS scores rely on subjective patient reporting, which may be influenced by anxiety, expectations, or individual pain thresholds.

3. Complete blinding is challenging as Intradermal sterile water injection causes a sharp stinging sensation and TENS produces a tingling effect making it likely for participants to identify their assigned intervention.

4. Without a cross-over design, differences in individual pain perception may influence the comparison of outcomes.

Future scope of the study:

1. Expanding the sample size and conducting multi-centric trials can enhance generalizability and validate the findings.

2. Cross-over Study Designs: Allowing each subject to experience both modalities at different times could reduce inter-subject variability.

3. Integration with Other Modalities: Studying TENS or ISWI in combination with breathing techniques, acupressure, or massage for synergistic effects.

4. Applicability of TENS and ISWI in post-operative pain can be explored,various doses & routes of sterile water injection & its effect on VAS score reduction.

Conclusion:

Transcutaneous Electrical Nerve Stimulation (TENS) and Sterile Water Injection (SWI both interventions significantly reduced maternal pain scores and improves overall maternal satisfaction when compared to the control group, without adversely affecting the duration of labour, delivery outcomes, or neonatal well-being.

When compared directly, **TENS demonstrated several advantages over SWI**. It provided **more sustained, early and pronounced pain relief**, as evidenced by consistently lower VAS scores over time. TENS was also associated with **higher maternal satisfaction scores**, likely due to its non-invasive nature, immediate onset of action.

On the other hand, **SWI also proved to be a safe and effective method**, particularly for women experiencing lower back pain during labour. While pain relief with SWI was significant as compared to control it was **less sustained and slightly less effective** compared to TENS. However, it offered the advantage of simplicity, minimal equipment requirements, and rapid administration—making it a practical option in low-resource settings or when TENS is unavailable.

Both methods were well-tolerated with only minor, transient side effects like tingling with TENS and localized pain with SWI. Additionally, vaginal delivery rates were higher and fetal distress was lower in both intervention groups compared to the control, indicating a positive influence of labour analgesia on labour outcomes.

In conclusion, **TENS is the superior modality** in terms of analgesic efficacy and maternal satisfaction. However, **SWI remains a valuable alternative**. Integrating these non-pharmacological techniques into routine obstetric care can enhance the labour experience, particularly in resource-constrained environments, by offering safe, effective, and patient-friendly options for pain management.

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Ethical Approval: The study protocol was approved by the Institutional Ethics Committee of Pandit Jawaharlal Nehru Memorial Medical College, Raipur, Chhattisgarh, India. All procedures were conducted by the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent: Informed consent was obtained from all individual participants included in the study.