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Research Article

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Surgical Treatment of Hyperhidrosis: Current Modalities, Challenges, and Future Directions

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1. Introduction

Hyperhidrosis, characterized by excessive sweating beyond physiological needs, significantly impacts patients' quality of life. Surgical interventions are often offered when conservative measures fail. This paper investigates the current surgical modalities for hyperhidrosis, highlights recent advancements, and explores future directions, and addressing associated challenges [1].

2. Background on Hyperhidrosis

2.1. Prevalence and Impact of Hyperhidrosis

In the United Kingdom, hyperhidrosis is estimated to affect approximately 1-2% of the population, with primary focal hyperhidrosis being the most prevalent subtype. The condition typically begins in childhood or adolescence and has a profound impact on patients' quality of life. Individuals often experience significant psychological distress, including social anxiety and diminished self-esteem, due to the visibility and persistence of excessive sweating. This underscores the importance of timely diagnosis and effective management strategies [2].

Figure 1: Left hand hyperhidrosis

2.2. Objective of the Study and Rationale

This study aims to evaluate current surgical treatments, their efficacy, and future trends, providing insights for clinicians and researchers.

2.3. Pathophysiology of Hyperhidrosis

Understanding Sweating Mechanisms

Sweating is controlled by the autonomic nervous system, primarily the sympathetic division. Hyperhidrosis is linked to hyperactivity in the eccrine sweat glands, particularly in focal areas such as palms and axillae.

2.4. Epidemiology and Aetiology

Primary hyperhidrosis is idiopathic, with a genetic predisposition in some cases, while secondary hyperhidrosis stems from underlying conditions like endocrine disorders or neurological diseases.

2.5. Impact on Quality of Life

Patients report significant physical discomfort, occupational challenges, and emotional strain, necessitating effective interventions.

2.6. Surgical Treatments for Hyperhidrosis

2.6.1. Open Trans axillary Thoracic Sympathectomy

During open trans axillary thoracic sympathectomy, the patient is positioned laterally with the axilla exposed. Proper arm support is essential to prevent brachial plexus injury. The procedure begins with a transverse axillary incision extending from the latissimus dorsi posteriorly to the pectoralis major anteriorly. Care is taken to avoid traction on the intercostobrachial nerve, which could lead to postoperative neuralgia, and to prevent damage to the long thoracic nerve, reducing the risk of winging of scapula. The sympathetic chain is accessed by entering the second intercostal space and dividing the overlying parietal pleura after lung collapse. This provides a direct view of the sympathetic chain in the superior sulcus, allowing its division.

2.7. Thoracoscopic Sympathectomy

Thoracoscopic sympathectomy offers significant advantages over open surgery, including improved visualization, reduced postoperative pain, enhanced cosmesis, and faster recovery. Patients are placed in the supine position with arms outstretched, and lung collapse is facilitated by positioning the operating table in reverse Trendelenburg. A small incision is made for a 5-mm trocar, with careful placement to avoid damage to intercostal neurovascular structures or the lung. The thoracic cavity is insufflated with CO_2 at pressures of 10–12 mmHg to improve exposure of the sympathetic chain beneath the parietal pleura.

The procedure may involve a single or dual-port approach. Division or ablation of the sympathetic chain is performed at the second or third rib level, typically sparing the ganglia. Techniques include diathermy, clipping, or excision, with the extent of ablation tailored to reduce the risk of complications, such as compensatory hyperhidrosis and Horner's syndrome [3].

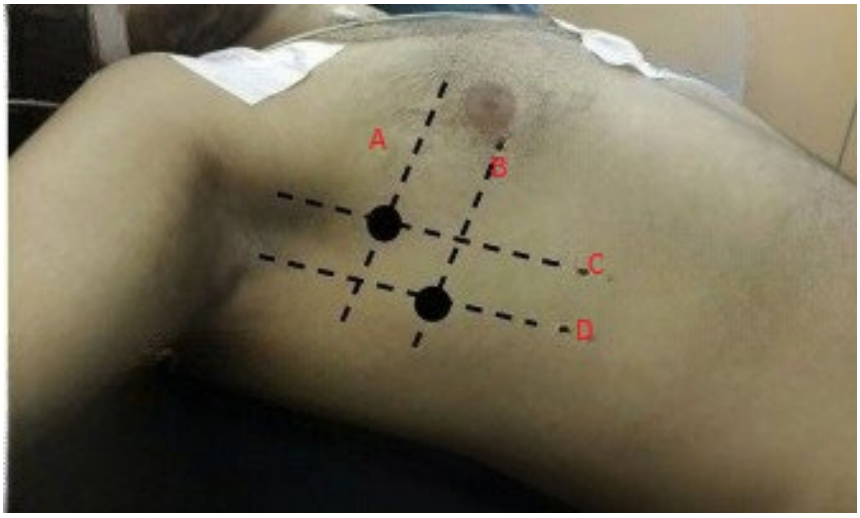

Figure 2: anatomical landmarks for Thoracoscopic sympathectomy access A: 3rd intercostal space B: 5th intercostal pace C: Anterior axillary line D: Posterior axillary line

2.8. Level and Extent of Sympathectomy

The optimal level for sympathectomy remains a topic of debate, particularly for severe palmar and plantar hyperhidrosis. Division at T2 is generally preferred as it effectively targets palmar sweat glands, while avoiding T1 minimizes the risk of Horner's syndrome. Evidence suggests that more limited procedures, such as division at T2 alone, may reduce the incidence of compensatory hyperhidrosis compared to more extensive ablations at T2–T4 [4]. However, selective sympathectomy targeting only the rami communicants has shown high rates of symptom recurrence.

Surgical techniques such as clipping the sympathetic chain allow for potential reversal, but the success of reversal procedures remains inconsistent. Alternative approaches, including grafting the sural nerve, have produced limited outcomes (3).

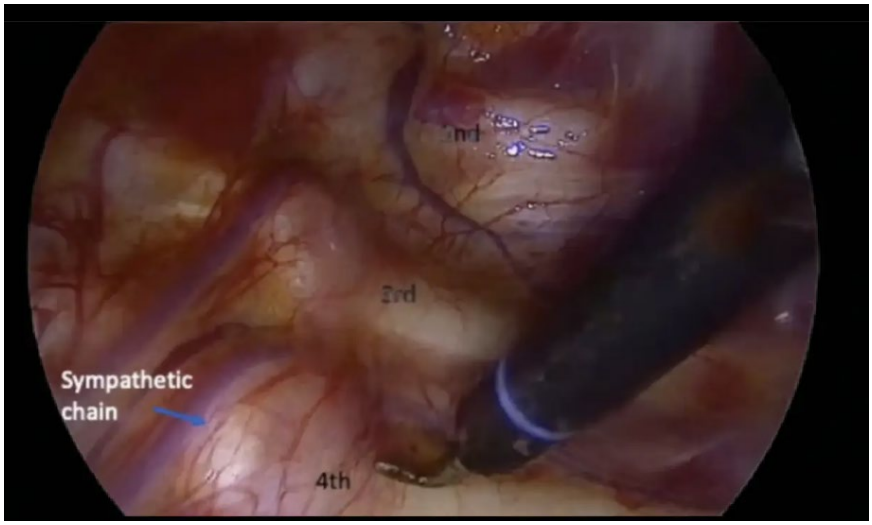

Figure 3 : Level and extent of Sympathecomy

2.9. CT-Guided Thoracosympatholysis

CT-guided injection of agents such as phenol or alcohol has been explored for sympathetic chain ablation. However, long-term outcomes have been suboptimal, and risks of complications are comparable to those associated with thoracoscopic sympathectomy [5].

2.10. Thoracoscopic Sympathectomy for Axillary and Cranio-Facial Hyperhidrosis

Thoracoscopic sympathectomy demonstrates higher efficacy in treating palmar hyperhidrosis compared to axillary and craniofacial forms. While 98% of palmar hyperhidrosis patients report symptom improvement, only about 63–68% of those with axillary hyperhidrosis achieve similar results. Non-surgical treatments, such as botulinum toxin injections, are generally preferred as first-line therapy for axillary hyperhidrosis.

For craniofacial hyperhidrosis and facial flushing, sympathectomy is effective but associated with a higher risk of compensatory hyperhidrosis and patient dissatisfaction. Sympathetic chain division at T2/T3 is typically recommended [6].

2.11. Local Surgical Procedures for Axillary Hyperhidrosis

Local surgical approaches for axillary hyperhidrosis include excision of sweat-bearing skin, subcutaneous tissue removal, glandular ablation, curettage, and liposuction. These methods effectively reduce symptoms and carry a lower risk of compensatory hyperhidrosis compared to thoracoscopic sympathectomy. However, they are not without complications, such as scarring, wound infection, and skin necrosis [7].

2.12. Intraoperative and Postoperative Complications of Sympathectomy

Intraoperative complications include challenges with access and locating the sympathetic chain. Pleural adhesions, which occur in 1–6% of patients with a history of respiratory issues or thoracic surgery, are more common in older individuals. These adhesions can typically be addressed with adhesiolysis, but in some cases, conversion to open surgery may be necessary. The sympathetic chain's location can sometimes be obscured by adipose tissue, or, particularly on the right side, by the prominent azygos vein, making the procedure difficult or incomplete.

Arterial injury, though rare, can occur if the subclavian arteries or the aortic arch are damaged. This typically requires a thoracotomy for arterial control and repair. Venous bleeding, occurring in up to 5% of cases, is usually due to injury to the intercostal veins during dissection of the sympathetic chain and can often be managed thoracoscopically using clips or diathermy [8].

Other rare intraoperative complications include:
• Arrhythmias and cardiac arrest following sympathetic chain division.
• Cerebral edema associated with CO2 insufflation.
• Pulmonary embolus and pulmonary edema.

Postoperative complications include pneumothorax, which may result from insufficient lung re-expansion, typically resolving without intervention in a few days unless it requires a chest drain. More severe pneumothorax may occur due to lung injury or rupture of a bulla, necessitating chest tube drainage. The reported incidence of pneumothorax is up to 25%, though chest drainage is required in only 0.3–6% of cases. Other rare postoperative complications include subcutaneous emphysema (in up to 2.7% of cases), pleural effusion (0–1%), chylothorax (due to injury to the thoracic duct), segmental collapse, and atelectasis.

Brachial plexus injury can occur from poor positioning or direct damage, particularly in supraclavicular sympathectomy procedures. Wound infections are infrequent but may occur at axillary port sites.

2.13. Horner's Syndrome

A significant complication of sympathetic chain surgery is Horner's

syndrome, which results from injury to the T1 (stellate) ganglion. This complication is reported in 0–5.6% of cases and can present as partial or complete, with ptosis and papillary constriction as the most visible signs. Temporary ptosis is relatively common, affecting up to 1% of patients. The causes of indirect damage to the T1 ganglion include thermal or electrical injury due to diathermy or traction injuries. Rhinitis may also occur in up to 10% of cases due to T1 injury. Persistent bradycardia has been noted following bilateral T2 sympathectomy [9].

2.14. Failures and Recurrence

Failures and recurrence may occur due to failure to locate the sympathetic chain, the presence of anomalous anatomy (e.g., the nerve of Kuntz), incomplete disruption of the sympathetic chain, or nerve regeneration. In such cases, re-sympathectomy may be necessary but should only be performed by an experienced surgeon [10].

2.15. Side Effects: Compensatory Hyperhidrosis

The most common side effect of sympathetic chain surgery is compensatory hyperhidrosis, where excessive sweating occurs in areas such as the trunk, groin, or legs, after treatment for palmar/plantar, axillary, or craniofacial hyperhidrosis. In some cases, compensatory hyperhidrosis can be more debilitating than the original condition. The incidence of mild compensatory hyperhidrosis is estimated to range from 14% to 90%, with severe cases occurring in 1.2–30% of patients. The condition can affect the feet (32%), face (27%), and trunk (20%), with gustatory sweating (1–51%) occurring in some individuals, particularly when consuming hot or spicy foods.

The mechanisms behind compensatory hyperhidrosis include thermoregulation adjustments due to denervation or alterations in hypothalamic feedback controls for sweating. Severe compensatory hyperhidrosis seems to be more common in patients who undergo excision of the T2 ganglia and in those who have more extensive resections (T2–T4). The severity of side effects does not significantly differ between techniques, whether surgical excision, diathermy ablation, or clipping of the sympathetic chain [11].

2.16. Comparative Analysis of Surgical Versus Non-Surgical Treatments

2.16.1. Effectiveness of Surgical vs. Non-surgical Approaches

Surgical treatments, such as Endoscopic Thoracic Sympathectomy (ETS), offer long-term and definitive relief from conditions like hyperhidrosis (excessive sweating), which non-surgical treatments struggle to achieve. Non-surgical options, including botulinum toxin injections and topical agents, provide more transient relief and may require repeated treatments for sustained effectiveness.

Botulinum toxin injections work by temporarily blocking the nerves responsible for sweating, but the effects wear off after a few months, necessitating regular follow-up procedures. Topical agents, like aluminium chloride, can be effective but often cause skin irritation and only provide partial symptom control. While non-surgical treatments may be preferable for patients who are not ideal candidates for surgery or prefer less invasive options, the results are generally less predictable and less permanent than surgical alternatives [12].

2.17. Patient Satisfaction and Quality of Life Improvements

Surgical treatments tend to offer more substantial and longer-lasting relief, which generally leads to higher patient satisfaction. Studies suggest that patients who undergo surgeries like ETS often experience significant improvements in their quality of life, as they no longer need to manage the symptoms of hyperhidrosis on a daily basis. However, satisfaction levels can be influenced by factors such as surgical complications, side effects (like compensatory sweating), and patient expectations.

In contrast, non-surgical treatments offer temporary relief, but the need for ongoing procedures or management can be frustrating. Patients who choose non-surgical approaches may report varying degrees of satisfaction, often depending on the duration of symptom relief and the frequency of required treatments [13].

2.18. Cost-effectiveness and Accessibility

While surgical treatments like ETS are initially expensive, they are generally more cost-effective in the long run compared to non-surgical alternatives. This is because the cost of multiple botulinum toxin injections or ongoing use of topical agents can add up over time, potentially surpassing the one-time expense of surgery. Furthermore, the lasting effects of surgery reduce the need for repeat treatments, contributing to its overall cost-effectiveness [14].

2.19. Recent Advances and Innovations in Surgical Techniques

2.19.1. Technological Developments and New Approaches

Robotic-assisted sympathectomy and targeted nerve modulation are emerging as precise and effective options with fewer side effects.

2.20. Case Studies and Clinical Trials

Recent trials highlight the efficacy of hybrid techniques combining minimally invasive and traditional approaches, improving patient outcomes [15].

2.21. Future Directions in Treatment

2.21.1. Ethical and Psychological Considerations

• Ethical Issues in Surgical Interventions: The risk-benefit ratio, particularly for compensatory sweating, raises ethical concerns.
• Psychological Impact and Patient Counseling: Pre-surgical counseling is crucial to manage expectations and mitigate postoperative dissatisfaction.
• Socio-cultural Factors Influencing Treatment Decisions: Cultural attitudes toward sweating and access disparities influence treatment uptake.

3. Conclusion

3.1. Summary of Key Findings

Surgical treatment for hyperhidrosis offers significant relief,

particularly in severe cases, but is accompanied by notable risks.

3.2. Implications for Clinical Practice

Clinicians should prioritize patient selection and counselling to optimize outcomes and manage expectations.

3.3. Recommendations for Future Research

Future research should focus on refining minimally invasive techniques, understanding the genetic basis of hyperhidrosis, and addressing compensatory sweating through targeted approaches.

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