Comparative Study between T3 and T4 Thoracoscopic Sympathicotomy in Management of Primary Palmar Hyperhidrosis in Pediatric Age Group

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Introduction: Hyperhidrosis, while not life-threatening, can significantly disrupt daily life. Thoracoscopic sympathetic chain sectioning is the most effective treatment for children with severe cases. However, compensatory hyperhidrosis (CH) is a common side effect, affecting 50-90% of patients. The optimal level for sympathetic chain interruption is debated, aiming to minimize damage to afferent fibers that regulate the sudomotor center. This study compares outcomes of sympathicotomy performed at the third versus fourth rib (T3 vs. T4).

Patients and methods: This prospective, single-blind, randomized controlled trial included 50 pediatric patients with primary palmar hyperhidrosis, treated between April 2020 and April 2022. Participants were randomly assigned to two equal groups. Exclusion criteria comprised mild hyperhidrosis, successful medical treatment, contraindications for thoracoscopic surgery, and suspected secondary hyperhidrosis. One-year postoperative follow-up assessed therapeutic success, side effects, over-dry hands, recurrence, and CH. Patient satisfaction was evaluated using a visual analog scale.

Results: The patients' ages ranged from 5 to 17 years (Mean 11.22 ± 3.31). Symptoms began between ages 4 and 12 (Mean 6.74 ± 2.02). The cohort included 17 males (34%) and 33 females (66%). Group B experienced more cases of moist hands compared to Group A (16 vs. 2). Over-dry hands were more frequent in Group A (6 cases) than in Group B (1 case). Recurrence occurred in one case in Group A and two cases in Group B. CH was significantly higher in Group A (56% vs. 16%; p = 0.015), with two severe cases in Group A and none in Group B.

Conclusion: T4 thoracoscopic sympathicotomy offers comparable success to T3, with the added benefits of a higher incidence of moist hands, reduced CH rates, and improved patient satisfaction.

Key words: Hyperhidrosis, thoracoscopic, sympathectomy, sympathecotomy, compensatory hyperhidrosis.

Introduction

Hyperhidrosis is a benign sympathetic disorder characterized by excessive sweating disproportionate to physiological thermoregulation needs. Although not life-threatening, it significantly impacts daily activities, leading to psychological distress, depression, and social withdrawal. Hyperhidrosis disrupts patients' social interactions, studies, and careers, negatively affecting their quality of life (QOL).[1] Primary hyperhidrosis (PH) affects 1% to 3% of the population, including 1.6% of children and adolescents. It typically manifests in childhood or adolescence and persists throughout life. While both sexes are affected equally, females are more likely to seek medical attention.[2]

Thoracoscopic sympathetic chain sectioning (Sympathotomy or sympathicotomy) or resection (Sympathectomy) remains the most effective treatment for primary palmar hyperhidrosis in children, particularly in severe cases. This approach offers long-lasting results and significant improvement in QOL.[3] However, despite its success, significant complications, especially compensatory hyperhidrosis (CH), can occur. CH is a common and troublesome adverse effect, affecting 50-90% of patients and being severe in 35% of cases, which may lead some patients to regret the surgery.[4] The mechanism of CH is not well understood, and there is currently no effective treatment. A key predisposing factor for CH may be sympathetic block at the level of the 2nd rib or possibly at multiple levels. To reduce the incidence and severity of CH, lower or more limited levels of sympathectomy have gained popularity.[5]

The optimal level of sympathetic chain interruption remains controversial. Some researchers suggest that lower levels of sympathetic intervention cause less damage to the afferent fibers responsible for regulating the sudomotor center. This hypothesis may explain the reported advantages of thoracoscopic sympathectomy at the level of the 4th rib compared to the 3rd rib, particularly regarding higher patient satisfaction and fewer complications, such as over-dry hands and CH.[6]

This study aims to compare the outcomes of two different levels of thoracoscopic sympathicotomy—the third rib (T3) versus the fourth rib (T4)—in managing primary palmar hyperhidrosis in the pediatric population. The primary comparisons will focus on therapeutic success, side effects, patient satisfaction, and quality of life.

Patients and methods

This prospective, single-blind, randomized controlled study included 50 pediatric patients presenting with primary palmar hyperhidrosis between April 2020 and April 2022. Patients were randomly divided into two equal groups using a closed envelope

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method. Group A (T3 group) consisted of patients who underwent thoracoscopic interruption of the sympathetic chain at the level of the 3rd rib. Group B (T4 group) included patients who underwent thoracoscopic interruption of the sympathetic chain at the level of the 4th rib **(Figs. 1,2)**.[7]

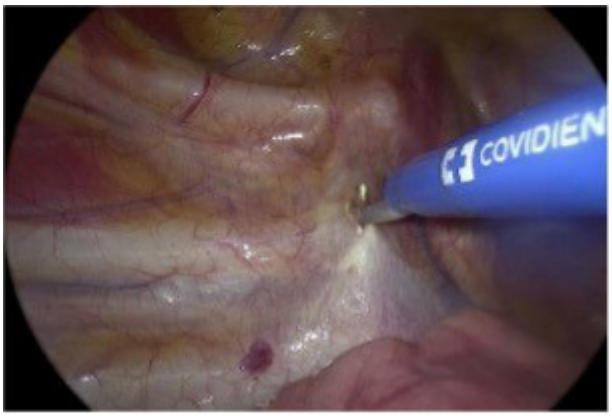

Fig 1: Cauterization of the adjacent costal pleura is done either side of the sympathetic chain.

Fig 2: The sympathetic chain is elevated by the hook from its bed and cauterized.

Inclusion criteria required visible, exaggerated sweating lasting for at least six months, failure of medical management, and severe primary palmar hyperhidrosis, classified as grade 3 or 4 according to the Hyperhidrosis Disease Severity Scale (HDSS). Exclusion criteria included mild palmar hyperhidrosis responding well to medical treatment, contraindications for thoracoscopic surgery (e.g., major cardiac anomalies or severe pulmonary hypertension), and secondary hyperhidrosis due to conditions like hyperthyroidism, pheochromocytoma, Hodgkin's disease, or psychosis. Patients were further categorized into three groups based on the degree of sweating severity.

Patients were followed up at one week, one month, six months, and one year postoperatively. Follow-up assessments were conducted in person or via phone calls, during which patients completed questionnaires. The outcomes evaluated included therapeutic success, defined as the absence of palmar symptoms, and the occurrence of adverse effects such as Horner's syndrome and bradycardia. Additionally, side effects like overly dry hands or moist hands (Recurrence) and the development of compensatory hyperhidrosis (CH) were monitored. Patient satisfaction was assessed using a Visual Analog Scale (VAS), with scores ranging from 0 (Extreme dissatisfaction) to 10 (Excellent satisfaction). Institutional review board approval was obtained before the initiation of the study.

Statistical Analysis: Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 25.0 (Armonk, NY: IBM Corp.). Quantitative data were expressed as mean ± standard deviation (SD) or as median and range, depending on distribution. Qualitative data were expressed as frequencies and percentages. For group comparisons, Independent Sample t-tests and Mann-Whitney U tests were utilized, while Pearson's correlation test was applied to detect relationships between study variables. A p-value of ≤ 0.05 was considered statistically significant.

Results

The age of patients at the onset of hyperhidrosis ranged from 4 to 12 years, with a mean of 6.74 ± 2.02 years. The median age at onset was 6 years in Group A and 7 years in Group B. The cohort consisted of 17 males (34%) and 33 females (66%), resulting in a male-to-female ratio of 1:1.9. The ages of the study participants ranged from 5 to 17 years, with a mean of 11.22 ± 3.31 years **(Table 1).** All patients presented with both palmar and plantar hyperhidrosis, while nine had associated axillary hyperhidrosis (four in Group A and five in Group B). The severity of palmar hyperhidrosis was moderate in 18 cases and severe in 32 cases. No significant differences were found between the groups in terms of demographic data, family history, or clinical characteristics **(Table 2).**

During the initial follow-up, dry hands were more prevalent in Group A (18 cases, 72%) compared to Group B (6 cases, 24%). In contrast, moist hands were significantly more common in Group B (19 cases vs. 3 cases). Compensatory hyperhidrosis (CH) was more frequent in Group A (28% vs. 12%); however, the severity was mild in all cases, and the difference was not statistically significant. After one month, one patient in Group A experienced a recurrence of palmar hyperhidrosis (wet hands), while the incidence of CH increased in Group A (36% vs. 12%).

At the six-month follow-up, dry hands remained more common in Group A (16 cases) compared to Group B (6 cases), while moist hands continued to be significantly more prevalent in Group B (16 cases vs. 2 cases). Over-dry hands were more frequently reported in Group A than in Group B (6 cases vs. 1

case). Recurrence of palmar symptoms (wet hands) was observed in one patient from Group A and in two patients from Group B, though this difference was not statistically significant. CH remained more common in Group A (56% vs. 16%, p = 0.015), with mild severity in Group B, while two patients in Group A experienced severe CH.

After one-year, moist hands were still more common in Group B (16 cases vs. 2 cases), while over-dry hands remained more frequent in Group A (6 cases vs. 1 case). One case of recurrent palmar hyperhidrosis (Wet hands) persisted in Group A, while two cases were observed in Group B. CH continued to be significantly higher in Group A (56% vs. 16%, p = 0.015), with all cases in Group B remaining mild, while two patients in Group A continued to experience severe CH **(Table 3).**

Patient satisfaction varied significantly between the groups. In Group A, 48% of patients were satisfied, 24% were unsatisfied, 20% were very satisfied, and 8% were very unsatisfied. In contrast, in Group B, 56% of patients were very satisfied, 32% were satisfied, 4% were unsatisfied, and 8% were very unsatisfied **(Table 4).**

The development of both compensatory hyperhidrosis and over-dry hands were identified as risk factors for decreased postoperative satisfaction. A higher satisfaction rate was observed in patients without CH (Mean = 4.34 vs. 3.0). Additionally, decreased satisfaction was noted in patients who experienced over-dry hands (Mean = 1.85 vs. 4.18).

Table 1: Demographic data of the studied groups

Variable	Group A N=25(%)	Group B N=25(%)	Test of significance
Age mean±SD	10.52 ± 2.96	11.92 ± 3.56	p=0.137
Sex			
Males	9 (36%)	8 (32%)	p=0.765
Females	16 (64%)	17 (68%)	

*statistically significant (p<0.05).

Table 2: Clinical Data of the studied groups

Complaint	Group A (N=25 %)	Group B (N=25 %)	Test of significance
Axillary hyperhidrosis	4 (16%)	5 (20%)	p=0.713
Onset (Years) Median (Range)	6 (4-10)	7 (4-12)	p=0.240
Degree			
Moderate	10 (40%)	8 (32%)	p=0.556
Severe	15 (60%)	17 (68%)	

*statistically significant (p<0.05).

Table 3: Clinical outcome and complications during the follow-up

Variable	1 Week			1 Month			6 Month			1 Year		
	Gr(T3)	Gr(T4)	P value	Gr(T3)	Gr(T4)	P value	Gr(T3)	Gr(T4)	P Value	Gr(T3)	Gr(T4)	P value
Hands:												
Dry	18	6*	.001*	18	6*	.001*	16	6	.001*	16	6	.001*
Moist	3	19	.001*	2	19	.001*	2	16	.001*	2	16	.001*
Overdry	4	0	1.0	4	0	1.0	6	1	.042	6	1	.042
Recurrence	0	0	1.0	1	0	1.0	1	2	.552	1	2	.552
CH												
Presence	7	3	.239	9	3	.508	14	4	.015	14	4	.015*
Degree												
Tolerated	7	3	.288	9	3	.160	12	4	.149	12	4	.149
Severe	0	0		0	0		2	0		2	0	

*statistically significant (p<0.05).

Table 4: Satisfaction score

	Group A (T3) N=25(%)	Group B (T4) N=25(%)	Test of significance
Very Unsatisfied	2 (8.0)	2 (8.0)	
Unsatisfied	6 (24.0)	1 (4.0)	
Neutral	0	0	P=0.012*
Satisfied	12 (48.0)	8 (32.0)	
Very satisfied	5 (20.0)	14 (56.0)	

*statistically significant (p<0.05).

Discussion

Hyperhidrosis is a relatively common condition, affecting approximately 1-3% of the population. Although hyperhidrosis is not life-threatening, it significantly impacts social interactions, mental health, and quality of life (QOL), potentially leading to social isolation or even depression. While surgical treatment has proven effective, postoperative side effects such as compensatory hyperhidrosis (CH) and over-dry hands, with varying incidence and severity, are commonly reported across different studies. These unfavorable side effects, which represent the primary drawback of the surgical technique, are the focus of evaluation in our study.[8]

The T2 ganglion has traditionally been considered the primary innervation for the hands. However, T2 sympathectomy has been associated with complications such as dry hands and facial denervation. It is suggested that cessation of head and facial sweating might lead to excess sweating on the trunk.[9] Similarly, Schmidt et al. reported that avoiding this level could potentially limit this side effect.[10] An anatomical study indicated that preganglionic fibers to the upper limb arise predominantly from the third to sixth segments of the spinal cord, with the third and fourth segments being particularly critical.[11] However, the optimal segment for interruption in the management of primary hyperhidrosis (PH) remains debated. Lin and Wu reported that limited fibers from T2 or T3 supply the hands, while fibers from T4 to the palm travel through T2 and T3.[12] Furthermore, Musa et al. demonstrated that the primary presentation—whether palmar, axillary, or plantar hyperhidrosis—affects the success rate, with 98.3% of patients with palmar hyperhidrosis achieving complete resolution post-sympathectomy, compared to only 5.1% of patients with axillary and plantar hyperhidrosis.[13]

In our study, three patients experienced a recurrence of symptoms, with one case in Group A and two cases in Group B. Drott and Claes noted failure to treat sweating in 1.5% and delayed appearance of re-sweating in 2% of patients.[14] In a study by Kim et al. involving over a hundred patients, the T3 group showed a higher recurrence rate compared to the T4 level (1.8% vs. 3.2%).[15]

The incidence of incomplete dryness of the hands (mild moist hands) was significantly higher in the T4 group (16 out of 25, 64%) compared to the T3 group (2 cases, 8%). In most cases, this was well-tolerated by the patients, with slight moistness occurring primarily in hot weather. Interestingly, patient satisfaction was higher among those with mildly moist hands than among those with completely dry hands. Liu et al. also reported a higher occurrence of mild hand moistness in the T4 group (59.4%) compared to the T3 group (25.8%), with most patients expressing satisfaction with this outcome, except for four patients (5.8%) in the T4 group.[16] Choi et al. found that a slight degree of moisture in the hands was more practical in daily life, suggesting that the ideal surgical outcome for PH is to avoid dryness and maintain a low level of moisture in the hands.[17] Hashmonai et al. emphasized that while surgeons typically view dry hands as the expected positive outcome, patients do not always share this perspective.[18]

Over-dryness of the hands is another potential complication. Despite reports of an over-dry hand incidence as high as 35%, no studies have elucidated the underlying mechanism.[16,19] In our study, over-dry hands were detected in four patients (16%) in Group A and none in the T4 group after one month of follow-up, a difference that was statistically significant. By six months, the incidence increased to six patients (24%) in Group A versus one patient in Group B. Compared to wet hands and compensatory hyperhidrosis (CH), over-dry hands had less impact on patients' daily activities and could be managed with regular use of topical cream. The primary factor influencing patient satisfaction was compensatory hyperhidrosis.

Compensatory sweating (CS) after thoracoscopic sympathectomy for hyperhidrosis is a very common side effect, with its reported incidence varying widely,[20] Zacherl et al. reported an incidence of 69% in a large series,[21] while Fredman et al. found an even higher incidence of 90%.22 This variation is likely due to differences in surgical techniques, classification, and the subjective nature of the symptoms. Bell et al. observed that the probability and severity of CS vary significantly with age (P = 0.0006), being less in younger patients.[23] Various

solutions have been proposed to prevent CS. Many authors suggest that the level and extent of sympathetic chain disconnection are critical factors.[24] Wolosker et al. reported better results in the T4 sympathectomy versus T3 (71.42% vs. 100%) at six months follow-up.[25] Similarly, Liu et al. found a lower incidence (56.5% vs. 77.4%, p = 0.011).[16] Kocher et al. noted that several authors have provided evidence that approaching multiple levels of the sympathetic chain increases the rates of severe compensatory hyperhidrosis. Moreover, involvement of the T2 sympathectomy has been associated with higher rates of compensatory hyperhidrosis.[26]

In our study, at one month follow-up, nine patients (36%) in Group A had compensatory sweating compared to three patients (12%) in Group B. At six months, the incidence of compensatory hyperhidrosis (CH) increased in Group A to 14 cases (56%) versus four cases (16%) in Group B. Similar studies reported better results, showing that 40-45% of patients developed compensatory sweating.27,28 Additionally, in the study by Wolosker et al., the incidence of CH after one year of follow-up was higher in the T3 group than in the T4 group (100% and 75%, respectively).[25] T3 sympathicotomy may be more appropriate for patients with severe palmar hyperhidrosis (PH), while T4 sympathicotomy showed better results in cases of axillary sweating.29 Although T4 sympathicotomy theoretically leads to less denervation of the palms, it effectively resolves hand hyperhidrosis, and most patients are satisfied with the results.30 For these reasons, and due to its association with lower morbidity, T4 sympathicotomy can be viewed as the treatment of choice. The goal of treatment is to improve the quality of life rather than to completely eliminate sweating in the hands.

This study has several limitations. The technique used monopolar cautery, which may not precisely cut the chain at a single point, potentially affecting a longer segment than intended. Plantar hyperhidrosis was not studied as a target variable, which may influence patient satisfaction, and its improvement was not assessed. Additionally, axillary involvement was infrequent in the sample, limiting the representativeness of the outcomes. The study was single-blinded, as the operator was aware of the technique used; however, we do not believe this affected the outcomes. The technique was randomly applied to the study group, regardless of the severity of the condition, which could be addressed in future research.

Conclusion

T4 thoracoscopic sympathicotomy demonstrates an equivalent overall success rate compared to T3 thoracoscopic sympathicotomy, with added benefits such as a higher incidence of moist hands, lower rates of compensatory hyperhidrosis, and greater patient satisfaction.

Disclosure

The Authors have no conflicts of interest or financial ties to disclose.

Abbreviations

HH: Hyperhidrosis
QOL: Quality of life
PH: Primary hyperhidrosis
CH: Compensatory hyperhidrosis
CS: Compensatory sweating
T2: Sympathetic chain at level of 2nd rib
T3: Sympathetic chain at level of 3rd rib
T4: Sympathetic chain at level of 4th rib
VAS: The visual analog scale

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