Palmar Hyperhidrosis and its Surgical Treatment:

A Report of 100 Cases

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One hundred patients with primary palmar hyperhidrosis (HH) underwent bilateral upper dorsal sympathectomy (UDS) by the supraclavicular approach. Pre-operative epidemiological and clinical data are described. The immediate and late results, as well as the complications and side-effects are detailed. Follow-up was completed on 93 patients between four and 50 months after the operation (average 18 months). Of 93 patients, 91 had drying of the hands. In 58% some moisture returned to the hands but in no case did the hyperhidrotic state recur. Subjective patient evaluation was excellent or good in 83 patients (89%) and only one patient (a technical failure) was completely dissatisfied. Reasons for some degree of dissatisfaction with the operation were mainly compensatory HH in non-denervated areas, and Horner's syndrome. Compensatory HH usually decreased with passage of time and, permanent Horner's syndrome occurred in 8% of patients (4% of procedures). Technical failure can be avoided by use of frozen section examination intraoperatively. For severe cases of palmar HH that cause social, professional and emotional embarassment, bilateral simultaneous UDS by the supraclavicular approach is the procedure of choice: Morbidity is small, and almost all patients enjoy improved quality of life after the operation.

SWEATING OVER AND ABOVE physiological needs is called hyperhidrosis (HH). Hyperhidrosis may be secondary to a variety of peripheral, local and central neurological lesions, or a manifestation of systemic diseases such as hyperthyroidism or pheochromocytoma.[23] Secondary HH may be localised or generalised. Primary (idiopathic or essential) HH is clinically a localised lesion affecting mainly the palms, the feet and the axillae, with different combinations of severity and locations. The subject of this report is primary palmar HH. Almost all our patients had severe plantar HH as well, and some also had axillary HH.

Charles Dickens' description of Uriah Heep in *David Copperfield* beautifully depicts the classical picture of palmar HH, with all the social embarassment involved. The English medical literature does not disclose figures on the prevalence of this disease in the general population. A pilot epidemiological study of the young population in Israel indicates an incidence of 0.6–1% of hyperhidrosis of all severities and locations. We estimate that ¼ of these have severe palmar HH. Although there are no comparative data this incidence appears relatively high—possibly due to our warm climate. Reports from Northern Europe however indicate that a warm climate is not the main etiological factor.[14–16,23,26,31]

Similar to Cloward's observations[11] we too found a specific ethnic predisposition with a higher than average prevalence in Jews originating in North Africa, Yemen and the Balkan, and lower than average in Jews from Persia and Iraq.

Although various non-surgical methods of treatment have been tried there is general agreement that surgery is the only adequate modality. Leriche in 1934 was the first to perform the operation for primary HH.[27] In recent years there is an increasing number of reports on upper dorsal sympathectomy (UDS) or cervico-dorsal sympathectomy for HH. The largest series reported so far is that of Cloward on 76 patients.[11] We report here our experience with UDS for palmar HH in 100 patients.

Materials and Methods

During the four years between August 1971 and August 1975, 100 patients underwent UDS for palmar HH. The operation was a modification of Telford's supraclavicular procedure.[36–37] As a rule the operation was performed bilaterally in one session and T2–T3 ganglia were removed (Fig. 1). A detailed description

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of the operative technique is given elsewhere (submitted for publication).

Follow-up was completed on 93 patients between four and 50 months after the operation (Average follow-up period 18 months). A detailed questionnaire was completed on pre-operative data. In half the patients this was done preoperatively. Clinical charts were analyzed, a detailed post-operative history was obtained and a physical examination was performed.

Results

Pre-operative Data

Fifty-one of our patients were female and 49 were male. Their ages ranged from 13–39 years (mean 23 ± S.D.6). There were 34 white-collar professionals, 23 students, and 31 were manual workers.

The age of onset could not be defined by 41 patients who stated that they suffered from HH ever since they could remember. In 59 patients HH started between age three and 18 (average at age 9). Thus the duration of symptoms before surgery is about 15–20 years. Some reports mention puberty as the time of onset,[13,19] but this was the case in only one of our patients. HH has been described in a 3-month old baby,[10] and two of our patients reported it in 1½ and 2-year old sons.

Location of preoperative sweating. All 100 patients had plantar HH as well as palmar, and in 83 of them it was severe; 53 patients reported axillary HH, 19 of them severe; 16 had some facial HH; 12 patients reported other locations such as "the whole body," neck, trunk and legs. These data indicate that plantar HH is an integral part of the clinical picture of the so-called palmar HH. The existence of HH in other locations indicates it is probably a generalised disturbance.[4,5]

Palmar sweating was associated in some of our patients with cooling and paleness of the hands and in others with warming and flushing. About half the patients questioned directly described swelling of the fingers associated with the exaggerated sweating. Two had Raynaud's phenomena.

Patients with HH are unique in the fact that they can "feel" their sweating, describing a burning sensation, paraesthesias and the feeling of the sweat bursting out of the skin pores.

Seven patients had some associated dermatological lesion in the palms and feet, mainly chronic dermatitis and fungal infections.

HH was usually episodic reacting to external stimuli, but 30 patients reported a continuous state of exaggerated sweating persisting between episodes. The vast majority did not sweat during sleep, and were dry on awakening.

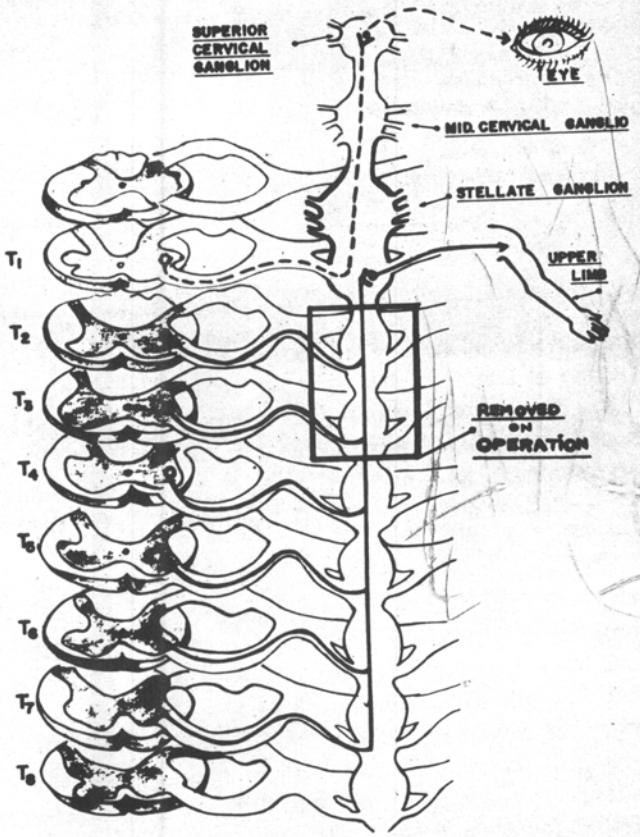

FIG. 1. Schematic and simplified representation of the surgical anatomy. The segment removed is blocked off.

Two thirds of our patients described worsening of HH during the hot summer months. In 10 female patients there was no change in the pattern of sweating during 17 pregnancies.

Familial history. In 53 patients there was some family history of HH of varying severity and in different locations. In 21 there was a strong family history of severe palmar HH in first degree relatives. Three pairs of siblings were operated upon by us. In two families three successive generations were affected. In four families several siblings were affected (4/7, 3/9, 5/6 and 4/6).

In 7 relatives with HH the conditions disappeared after the age of 20, possibly indicating a tendency towards amelioration with age. However one of our patients had a 77 year old father with persistent palmar HH. The familial tendency of HH is mentioned by other authors.[11,15,18,40]

Provoking stimuli. Table 1 enumerates the stimuli that provoked the episodes of HH in our patients. All three known physiological stimuli for sweating; Thermal, emotional and gustatory are represented, but

TABLE 1. *Stimuli Provoking Episodes of HH*

Emotional stimuli	98
Thermal stimulus	92
Fine manual tasks	76
Thinking about the predicament	67
Physical exercise	56
Sexual intercourse	20
Hot and spicy food and alcoholic drinks	15
Smoking	1
Exposure to cold	1

the emotional factor caused a much more severe degree of HH than the other stimuli.

Specific complaints. HH caused considerable social embarrassment in 90 patients and interfered with performance of everyday tasks in 95 patients. Only 40 patients admitted to psychological difficulties secondary to the HH.

The most consistent complaints were embarrassment when shaking hands, and difficulties in writing and drawing. Many patients independently developed a technique using two sheets of paper during writing: the top one to absorb the sweat and the other to write on. Seven mechanics and electricians described frequent electrical shocks to their moist hands. Some patients related difficulties with their cigarettes getting wet and messy. Others dropped glass objects from their hands, or had difficulties knitting or playing musical instruments.

Prior treatment. The via dolorosa of the many attempts at non-surgical treatment is described in Table 2. None of these treatments is effective except for anticholinergic drugs, however these cannot be tolerated because of their side effects. The variety of treatments attempted and the resorting to non-conventional methods by desperate patients indicates the futility of non-surgical treatment in severe cases.

Associated diseases. A few patients had other diseases, but the distribution of these appeared to be in accordance with their expected incidence in the general population.

TABLE 2. *Non-surgical Attempts at Treatment of HH*

Topical treatment (astringents, absorbing powders)	84
Anticholinergic drugs	32
Sedatives	16
Psychological and psychiatric treatment	16
Iontophoresis	8
Hypnosis	7
Irradiation of palms	6
Acupuncture	3
Physiotherapy (?)	1
Blood letting (?)	1
Sodium chloride tablets (?)	1
Chinese flowers (?)	1

Seven patients received psychiatric treatment for reasons not related to HH. However our impression was that the majority of patients did not have any basic psychiatric disturbance, excluding some mild neurotic traits which could well have been the results of HH. Our observations do not support the common view that HH is basically a psychiatric disturbance.

The Operation

Ninety-eight patients had a bilateral operation in one session, and two had one side operated upon after a transaxillary unilateral operation at another hospital. 4 patients in whom the operation failed on one side underwent transaxillary sympathectomy at a later date, for a total of 198 supra-clavicular and 6 transaxillary operations.

The operative approach is supra-clavicular, between the two heads of the sterno-cleido mastoid muscle. The phrenic nerve is retracted, the scalenous anticus is transected and the superior branches of the subclavian artery are ligated and divided. The subclavian artery is retracted caudally, Sibson's fascia is penetrated and the apex of the parietal pleura is pushed downwards revealing the stellate ganglion and the upper dorsal sympathetic chain. The chain is divided immediately below the stellate ganglion, and T2–T3 ganglia are removed. In case of doubt a frozen section is requested on the specimen. Saline is poured into the wound while the anasthetist inflates the lungs. If a pneumothorax is suspected the wound is closed over a small latex drain which is withdrawn after skin closure with the lungs fully inflated. A chest x-ray is usually obtained immediately to rule out pneumothorax. A tear of the pleura was noted during surgery in 41 procedures (21%). None of these developed a significant pneumothorax necessitating drainage.

Immediate results and complications. Of 198 procedures 191 resulted in drying of the hands (96.5%). In 6 patients (one on both sides) failure to achieve dry hands correlated with the histological report revealing no ganglion cells in the specimen. In two other patients with peripheral nerve fibers but no ganglion cells in the specimen on one side, the hands dried after the operation. Since we began using frozen section routinely in cases of doubt we have not had such failures. Four of the 6 patients with immediate failure requested re-operation—all with good results. The other two declined.

Other immediate sudomotor effects were: a) Complete drying of the feet in 26 patients, and partial drying in 22. Seven patients that retained plantar sweating noted that after the operation it occured only

with thermal and not with emotional stimuli. b) Severe unkal HH in 25. c) In 18 patients there was a clear story of a brief episode in palmar sweating appearing between 1–7 days after the operation followed again by complete drying of the hands. The episode lasted from a few minutes to 24 hours. The phenomenon had been noted by others[16,23,32] but no explanation was offered by them. It may represent a transient discharge of the transmittor substance at the nerve ending resulting from post-ganglionic degeneration. If it occurs the patient may be reassured that it is not a sign of failure of the operation.

Immediate complications. There was no mortality and no serious morbidity. A list of the immediate post operative complications is given in Table 3.

Pyrexia, an extremely common occurrence, is not an expression of infection. It appears within 24 hours and usually lasts for 24–48 hours subsiding spontaneously. No patient received antibiotics post-operatively.

We assume this pyrexia is an expression of failure of thermoregulation because of general "sympathetic shock" resulting from the operative damage to a part of the sympathetic system.

Pneumothorax necessitating drainage occurred only 6 times in patients in whom a tear of the pleura was not observed during the operation. This was probably the result of a missed pleural tear. Pleural effusion, always small, correlated with diagnosed pleural tears, and probably resulted from the saline poured into the wound.

The relatively high incidence of immediate Horner syndrome in our pre-ganglionic operation confirms recent anatomical knowledge: The cilio-spinal center is not sharply confined to T1 spinal level, but may extend downwards as low as T5.[8,17,39]

Brachial plexus contusion resulting from pressure of retractors usually involved the lower trunk (spinal roots C8 T1, Klumpke's Syndrome). It was usually mild and transient, and became less frequent with increasing experience.

Other complaints of post operative pain were of three types: 1) Post sympathetic neuralgia in 6 patients usually mild and always transient. 2) Muscular type pains in the neck, back and abdomen, probably secondary to the fasciculations induced by succinylcholine, or to the hyperextension of the neck during the operation. 3) Pleuritic type chest pain probably due to irritation of the apical pleura by the inevitable small hematoma in the operative field.

Average post-operative stay after the operation was four days, considerably shorter than in any other approach to UDS.

Late results and late sequellae. Ninety-three patients were followed for an average of 18 months. There were only 2 failures (one bilateral) in patients who refused further surgery. Of 91 patients with a good initial result 53 (58%) reported return of some moisture to the hands, while in 38 the hands remained completely dry. In no case was there a return to the hyperhidrotic state.

TABLE 3. *Immediate Complications Following 198 UDS in 100 Patients*

Pyrexia > 37.9°C		71
Dyspnea		37
Pneumothorax		17
mild	11	
severe (necessitating drainage)	6	
Pleural effusion, small		7
Horner		57
*mild	33	
remarkable	24	
Brachial plexus contusion		11
Recurrent laryngeal paralysis, transient		1

* Mild Horner does not cause a cosmetic defect, and is detectable only on close examination.

Return of moisture was asymmetrical in half the patients. In 7 cases (13%) the ulnar region of the palm representing C8 spinal dermatome was affected. Moisture returned between 1–12 months after the operation (average 5 months). The rate of this partial relapse was 70% in the first 45 patients and 48% in the last 45 patients, this difference confirming the increase of relapse with the increasing length of the follow-up.

Of 53 patients with partial relapse thermal stimuli caused sweating in 35 and emotional stimuli in 23, a clear-cut shift from the pre-operative pattern.

Of 48 patients who reported drying of the feet (complete or partial) immediately after the operation, the effect was maintained in 35—in only one were the feet completely dry. Forty-eight patients reported complete or partial drying of the face.

Only 9 procedures resulted in complete drying of the axillae, and 78 gave partial drying. Full drying of the axillae probably requires removal down to T5 ganglion,[18] but our procedure is deliberately less extensive, so that any effect on the axillae is incidental. In the 6 patients who had one side operated upon via the transaxillary route, the axilla was always dryer on that side. Using the Telford procedure axillary sweating, if present, is tackled not by a more extensive procedure, but rather by axillary skin excision. Some authors report doing this at the same session.[18] It is our prejudice that axillary skin excision is preferable to an extensive sympathectomy regardless of the approach, because an extensive sympathectomy will further aggravate the problem of compensatory hyperhidrosis (vide infra).

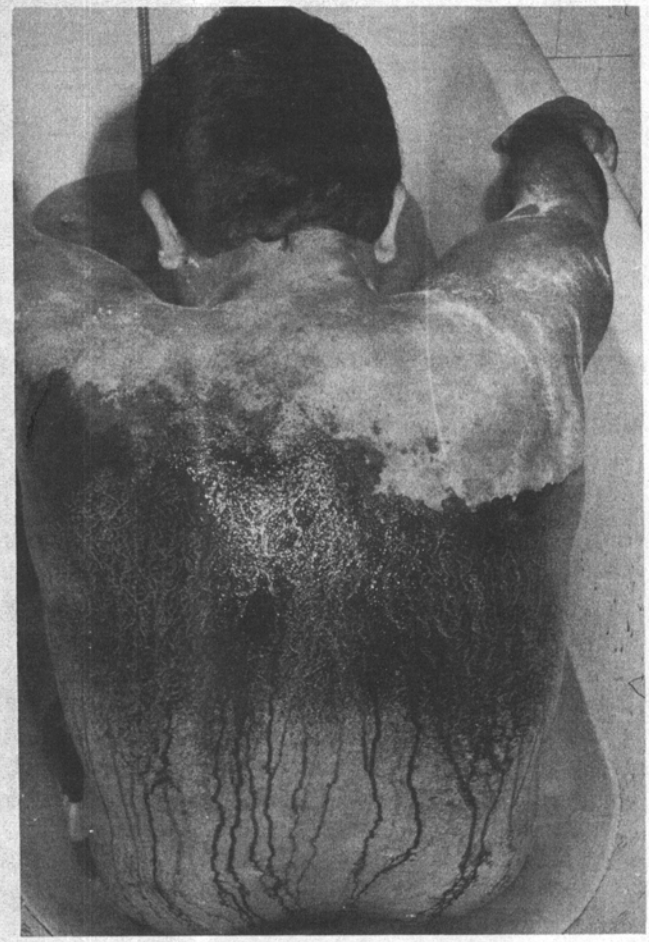

FIG. 2. Starch-iodine (Minor's) test demonstrating demarcation line between sweating and dry skin. Note profuse sweating below the line.

Seventeen patients reported a sharp line of demarcation on the chest and back wall between dry and sweating areas (Fig. 2). This represents similarity between cutaneous and so-called sympathetic dermatomes in this region. The axillae innervated by the T2 somatic dermatome are spared in these patients and retain their sweating.

Late sequellae. Late sequellae are summarized in Table 4. "Gustatory phenomena" were a frequent side effect of the operation and will be described in detail in another report. Patients responded with sweating in the face and other regions to a wide variety of gustatory stimuli. Gustatory phenomena appeared on the average of 5.5 months after the operation and are considered an expression of aberrant regeneration.

Compensatory HH in other areas of the body mainly trunk, axillae and thighs was reported by 59 patients, but only 24 regarded it as a significant handicap. The discomfort is maximal during the first summer after the operation, and the stimulus to this HH is thermal. On successive summers the phenomenon decreases in severity. Due to our hot climate we consider this frequent complication as a strong argument against the performance of four limb sympathectomy in HH. Patients usually accept this after an explanation. Compensatory HH has been reported almost invariably by different authors,[15,16,18,25,26,39] and appears to be more common and more severe after UDS for HH. This is probably an expression of the basic sudomotor defect in these patients.

"Phantom sweating" which is a feeling of sweating without actual sweating was first noted by one of us (M.M.), and subsequently found on direct questioning to be quite common in our patients. The phenomenon is a subject of a separate report (submitted), and includes the sensations that accompany sweating in these patients such as parasthesias, flushing and pruritus. It is considered by us as evidence of residual sympathetic activity in the denervated limbs.

Horner's syndrome was present in 40 patients but only in 8 was it remarkable. The total incidence is somewhat decreased from the immediate post-operative period (57% to 43%), but the remarkable syndrome is considerably decreased (24% to 8%). Of the mild Horners 40% disappear, and of the severe Horners only 13% disappear but most become mild.

Ptosis and miosis are the most constant elements of the post-operative Horner's syndrome. In some of the patients only one of the two was prominent. Facial anhydrosis although common did not correlate with the previous two signs. Of the ocular complaints only conjunctival hyperemia correlated well with ptosis and miosis. Mild impairment of vision was noted by 18 patients, non specific complaints of pain or itching were reported by 12, and in two patients a unilateral decreased secretion of tears was documented.

TABLE 4. *Late Sequellae in 93 Patients*

Gustatory phenomena		68 (73%)
Compensatory hyperhidrosis		59 (63%)
"Phantom sweating"		49 (53%)
Horner		40 (43%)
*Mild	32	
Remarkable	8	
Other occular complaints		38 (41%)
Respiratory complaints		18 (20%)
Wound problems		9
Hypoasthesia	7	
Keloid	2	
Cold hands		7
Dry hands (mild inconvenience)		5
Skin mottling		2
Mild residual brachial plexus damage		2
Blockage of nasal passages		2
Vasomotor Rhinitis		1
Fulminant dental caries		1

* See note to table 3.

Two patients with Horner's syndrome complained of blocking of the nasal passage on the involved side, and in one of them pre-existing vasomotor rhinitis was aggravated.

Horner's syndrome being an expression of the extent and type of sympathetic denervation, we examined the correlation between it and other manifestations of sympathetic activity.

Two major correlations were found. There was a negative correlation between the existence of a remarkable Horner and return of moisture to the hands ($p < 0.05$). There was also a negative correlation between severe Horner's syndrome and gustatory phenomena ($p < 0.01$).

Respiratory complaints, usually not specific and mild were mentioned by 18 patients. However in 2 patients there was a re-exacerbation of childhood bronchial asthma. One patient reported cessation of attacks of asthma after the operation.

Late wound problems were infrequent, consisting of hypoasthesia of the anterior chest wall as a result of severing the supraclavicular nerves, and keloid formation. Keloid was rare and the hypoasthesia not troublesome.

While most patients were happy with their hands, 5 complained of minor discomfort because their hands were "too dry." Seven patients reported the paradoxical effect of their dry hands becoming colder after the operation,[20,25] indicating a dissociation between sudo and vasomotor functions. A possible explanation is denervation hypersensitivity to circulating catecholamines.

Two patients developed a red-white mottling of the hands while dependent, that disappeared on elevation. This expression of vasomotor residual activity has been described by others after both dorsal and lumbar sympathectomies.[1,9,28]

Fulminant dental caries was reported in one young girl about one year after the operation. The relation to the operation is not certain, but a qualitative or quantitative change in the saliva resulting from sympathetic denervation is a possible explanation.

Patient satisfaction with the results of the operation was considered an important factor because the indication for surgery was a subjective one. Of 93 patients 54 defined the results as excellent and 29 as good for a total of 83 (89%) satisfied patients. Nine patients (7 females and two males) had some reservations but not enough to cause regret over having the operation. Only one patient, the one with bilateral failure, defined the results as poor.

The main reasons mentioned by 39 patients who did not describe the result as excellent were: 1) Compensatory HH (30 out of 39); 2) Horner's syndrome in 6; 3) Residual mild moisture in 6; 4) Gustatory phenomena in 4. Of these the most problematic both from the point of view of its incidence, and its severity, was the compensatory HH. This being an almost inevitable result of the operation in many patients, it should be clearly explained to the patients pre-operatively.

Discussion

Primary hyperhidrosis is considered a state of hyperreactivity of the sudomotor center.[11,40] Anatomical and functional examinations of the sweat glands, and histological studies of the sympathetic ganglia have failed to reveal any abnormality.[18]

It was generally accepted that thermal sweating normally occurred mainly in the trunk, while emotional sweating was confined to the palms, feet and axillae.[13,38] HH was accordingly considered as a disorder of emotional sweating. Allen et al.[4] showed that in normal subjects emotional stimuli increased sweating proportionately all over the body, but the clinical manifestation was in the palms and feet where the density of sweat glands was highest.[30] Allen et al. also examined hyperhidrotic patients[5] and demonstrated a generalized hyper-reactivity of emotional sweating affecting all body regions, more of course in the palms and feet. In our patients data were not obtained but our impression was that they hyper-reacted to thermal stimuli as well.

HH usually appears at an early age, often with a familial history. In its severe form it affects all aspects of the patient's life, and influences social behaviour and professional development. Although not a threat to life or organ integrity its effect may be quite crippling.

Although secondary HH may occur in some systemic or neurologic diseases, the clinical picture of primary HH is so clear cut, that a positive diagnosis can be made on the basis of the history and physical examination alone: On the whole the patients are young and healthy subjects. The complaint is of long duration with no change in its pattern, and no influence on the general health. The affection is symmetric and involves palms and feet mainly. The pattern of episodic exacerbation is constant reacting to the same stereotypical stimuli. Sweating is usually absent when the patient is completely relaxed as during sleep.

An extensive pre-operative work-up[23] is therefore unnecessary in the routine case. Also in a severe case attempts at non-surgical treatment are futile, and there is general agreement that UDS is the only treatment with a lasting effect. Of all the conditions for which UDS is performed HH gives the most rewarding results.

Of the three main surgical approaches for UDS—

supraclavicular (Telford),[36,37] transaxillary (Atkins)[6] and dorsal (Adson-Smithwick)[2,35] we prefer Telford's approach. Its main advantage is the minimal morbidity and short hospital stay. It is particularly suited to the treatment of HH, in which the sympathectomy should be deliberately of a small extent, in order to minimise the compensatory sweating in the non-denervated areas. Six patients who were in the position to compare Telford's to Atkins' operations (having undergone both) unequivocally preferred the supraclavicular operation.

The unpredictable variability of the denervation effect (Horner's syndrome, drying of the face, axillae and feet, compensatory HH, gustatory phenomena and different forms of return of moisture to the hands), in what is a standard operation, is probably an expression of individual anatomical variability of the sympathetic pathways, as well as some variations in the extent of the resection due to inaccurate identification of sympathetic segments during the operation.

The ideal sympathectomy would achieve a complete and permanent denervation. It is accepted that this is not feasible and in any form of operation sooner or later some relapse of sympathetic tone will occur.[9]

Our data demonstrate certain phenomena that may be an expression of residual sympathetic activity *e.g.* "Phantom sweating," mottling of the hands, and possibly post-sympathectomy neuralgia. We also encountered relatively early and quite frequent relapse of sympathetic activity in the form of return of some moisture to the hands. This relapse is not a return to HH and most patients enjoy this moisture more than they did their completely dry hands. It is worth noting that Sarkar using electrical conductance studies[33] showed that even in patients with clinically dry hands after the Telford operation, some sudomotor activity was still present.

The relapse does not appear to be a phenomenon of denervation hypersensitivity, nor a result of a persistent local factor such as may be present in Raynaud's disease. It is therefore a return of sympathetic tone due to: a) Regeneration[21] or collateral sprouting[7] or b) Residual sympathetic pathways traversing Skoog's ganglia,[3,34] the nerve of Kountz (quoted by 21) or white rami communicants to the upper extremity emerging from C8 T1 spinal levels.[9,17]

The pattern of relapse in some of our patients who reported moisture along the ulnar aspect of the hand, lends possible support to the theory that the relapse is an expression of residual sympathetic outflow from C8 spinal level, which innervates the ulnar region of the hand.

Various modifications of technique and approach have claimed theoretical advantages in delaying and decreasing the rate of relapse. However the final results are not significantly different with any of these variations.[20,24]

There is a wide spectrum of attitudes in the literature on the surgical treatment of HH. Some describe the operation as a minor procedure with excellent results and very few complications.[12,15,18,19,22] Others completely object to surgery for what they consider to be a benign functional disorder.[1] In our extensive experience the truth lies somewhere in between these two extreme views.

Severe palmar HH can be quite crippling, but the operation in spite of giving good results, should not be taken lightly. Apart from sequellae described in this report, some other aspects have not yet been fully investigated. These include possible denervation effects on bronchi and lungs, on the myocardium and the coronary circulation, on salivation and dental health, and on ophthalmic functions such as lacrimation and accomodation. Some studies along these lines are presently being pursued by us.

Accordingly our policy is by no means to encourage indiscriminate operation for all patients with HH. Patients referred to us receive a pamphlet enumerating possible side effects and sequellae. Some patients on reading it decide against the operation, thus we eliminate those patients whose discomfort is not so severe. We have found this simple maneuver helps those patients who do decide to undergo the operation to adjust better to the post operative sequellae.

On the whole primary palmar HH is a disabling condition, affecting all aspects of life in modern society. The operation is associated with minor morbidity, and its results, although by no means perfect, are generally good, almost always improving the quality of life.

Addendum

Since the completion of this paper a further 42 patients have had the operation, bringing the series up to 142. These added cases have not changed the basic data, although there was a lower incidence of technical operative complications such as severe Horner's syndrome, pneumothorax and brachial plexus injuries.

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