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A Technical Note

Distal thigh/arm index as a predictor of success for lumbar sympathectomy

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Abstract—Data from 90 lumbar sympathectomies were reviewed to assess the role of a distal thigh/arm Doppler systolic index (DTAI) and of external magnetic flowmeter (MCBF) measurements for predicting patient outcome following lumbar sympathectomy. The presenting symptoms included impending gangrene, gangrene, rest pain, nonhealing ulcers, and disabling claudication. Of the 90 cases, clinical improvement occurred in 57% of the limbs. Major amputation was not required in 73% of the limbs. The MCBF data showed variability which masked the relationship to the effects of sympathectomy. DTAI test results were significantly related to outcome. For DTAI >0.6 (57 patients), improvement occurred in 70% of the limbs, with major amputation not required in 86% of the limbs. For DTAI <0.6 (33 patients), improvement occurred in only 33% of the limbs, and major amputation was not required in 52% of the limbs. The Doppler systolic index has provided a noninvasive measure that can be used in conjunction with good clinical judgment for predicting the outcome of lumbar sympathectomy.

Key words: *disabling claudication, impending gangrene, nonhealing ulcers, noninvasive vascular testing, rest pain, sympathectomy.*

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INTRODUCTION

The role of lumbar sympathectomy in the management of patients with arteriosclerotic occlusive disease of the lower extremities remains a subject of considerable discussion. It is generally agreed that lumbar sympathectomy can increase lower extremity blood flow in patients with ischemic limbs (1,2,3). However, the nutritional tissue value of the modified blood flow has been questioned (4). In our experience, lumbar sympathectomy has been beneficial in patients with severe ischemia and gangrene of the foot, and particularly effective in salvaging digits in the presence of toe gangrene (5). There are a number of reports citing beneficial effects of lumbar sympathectomy in patients not amenable to direct arterial surgery (5,6,7). There are also articles reporting no effect (8,9), and even deleterious effects (10,11), from lumbar sympathectomy. Much of the confusion concerning the effectiveness of lumbar sympathectomy appears to be due to the differences in criteria for choosing patients who may benefit from the procedure.

We have previously proposed criteria for identifying patients most likely to benefit from the procedure (12). These are based on measurements of absolute Doppler systolic pressure, ankle-brachial

Journal of Rehabilitation Research and Development Vol. 30 No. 4 1993

Doppler systolic pressure index, external magnetic flowmeter measurement of peak pulsatile calf blood flow (MCBF), and on an absence of an ankle-toe temperature gradient. Criteria using Doppler systolic pressure have been reported by Yao and Bergan (13), Seeger, Lazarus, and Albo (14), and Walker and Johnson (15). Recently, Plecha and associates (16) have advocated using a distal thigh/arm pressure index (DTAI) in selecting patients for lumbar sympathectomy. Successful outcomes appear to depend upon methods of selecting patients for sympathectomy. Alternative criteria need to be evaluated objectively and quantitatively. In our study, two measures indicative of total limb flow were evaluated as predictors, namely MCBF and DTAI. This study compares outcomes for those patients who underwent sympathectomy. The relationship of outcome to criteria based on thresholds for MCBF and DTAI was examined.

METHODS

The charts of 90 patients undergoing sympathectomy were reviewed to determine the usefulness of the DTAI in predicting the outcome of this operation in a selected population. The data were derived only from patients with a previous sympathectomy. These patients had been selected for sympathectomy based on several criteria. First, a great majority of the patients were not amenable to reconstructive surgery because of an absence of a suitable outflow vessel determined by angiography. Second, the patients had impending gangrene or frank gangrene, rest pain, ulceration, and/or disabling claudication. Patients in the study were followed until a subsequent surgical procedure became necessary or until death. In the favorable outcome cases where sympathectomy was not followed by major amputation, the outcome was classified as to whether or not the presenting problems were improved or resolved following sympathectomy, without further surgical intervention or with minor surgical interventions including amputation of toes and/or a forefoot amputation. In three cases, lumbar sympathectomy was subsequently followed by a bypass operation. In all three a major limb amputation was not necessary.

Clinical testing of the patients included two noninvasive vascular diagnostic tests: the distal thigh/arm systolic pressure index (DTAI) and the external magnetic flowmeter measurement of mean calf blood flow (MCBF). These tests were chosen as possible predictors of blood flow changes following sympathectomy, since each is indicative of overall limb flow. The DTAI is derived from Doppler ultrasound flow measurements, while the MCBF measures blood flow in the limb bulk volume.

To examine the use of these tests as predictors, the test results were pooled into groups as a function of outcome. Then the *t*-tests were applied to test and to reject, where appropriate, the null hypothesis that there were no significant differences.

RESULTS

Table 1 shows the outcome of patients having lumbar sympathectomy grouped according to their clinical symptoms. The presenting problems were improved or resolved in 57 percent of the cases. Clinical improvement and prevention of major amputation were seen consistently in all clinical groups. Mean values of test results for the DTAI and MCBF are shown in **Table 2**. MCBF data were not obtained in 10 of the patients in the DTAI tested group due to technical problems and/or unavailability of patients. Both diagnostic tests as reported in **Table 2** show lower values associated with the unfavorable outcome of major amputation. Test results for unfavorable outcomes (third column, **Table 2**) were compared with test results for other outcomes (first and second columns, inclusive) with a null hypothesis of no difference in mean test values. The pooled *t*-test DTAI difference is significant ($p<0.005$), while MCBF data were not found to be significant. As seen in **Table 2**, the variability in MCBF was larger in each category than DTAI, when calculated as coefficients of variation, suggesting that DTAI is a more sensitive test.

The use of the DTAI as a predictive criterion has been developed further. The results are shown in **Table 3a** and **Table 3b** following selection of a DTAI threshold of 0.6. Each patient had one or more indications included in the table. The entries are the number of patients having a given indicator. The bottom lines show the overall number of cases with *any* indication in each outcome category. Note that this is not the sum of the patients in each category since some patients had multiple indicators.

Table 1.
Lumbar sympathectomy outcome by operative indications (numbers of cases).

Indication	Improved or Resolved Following Sympathectomy	Unresolved No Major Amputation	Required Subsequent Major Amputation
Impending Gangrene	9	0	1
Gangrene	18	1	19
Rest Pain	16	4	19
Ulceration	11	11	6
Disabling Claudication	17	4	1
Overall	51 (57%)	15 (15%)	24 (27%)

Table 2.
Noninvasive measurements by outcome [mean ± std. error (n)].

	Improved or Resolved Following Sympathectomy	Unresolved No Major Amputation	Required Subsequent Major Amputation
DTAI	.87 ± .05 (51)	.89 ± .10 (15)	.60 ± .07 (24)
MCBF	21 ± 2 (50)	19 ± 5(13)	16 ± 5 (17)

DTAI = Distal thigh Doppler systolic pressure index (above knee/arm).
MCBF = External magnetic flowmeter measurement of mean blood flow in the calf (ml/min).

Table 3a.
Distal thigh/arm index ≥ 0.6 (number of cases).

Indication	Improved or Resolved Following Sympathectomy	Unresolved No Major Amputation	Required Subsequent Major Amputation
Impending Gangrene	9	0	0
Gangrene	12	0	6
Rest Pain	12	2	5
Ulceration	11	7	3
Claudication	10	2	1
Overall	40	9	8

For the categorization of outcomes in **Table 2**, the numbers of patients were compared, contingent on outcome and index (DTAI >0.6 and DTAI <0.6). A Chi-square test was applied with the null hypothesis that there was no relationship between DTAI category and outcome category. The relationship between DTAI and outcome was significant ($p<0.005$). In **Table 3a** a summary is shown for patients whose DTAI was 0.6 or greater and in **Table 3b** that for patients whose DTAI was less than 0.6. In the former group, the rate of improvement and resolved problems was 70 percent, compared with 57 percent for the entire group. Major amputation was avoided in 86 percent of the patients. When

Table 3b.
Distal thigh/arm index < 0.6 (number of cases).

Indication	Improved or Resolved Following Sympathectomy	Unresolved No Major Amputation	Required Subsequent Major Amputation
Impending Gangrene	0	0	1
Gangrene	6	1	13
Rest Pain	4	2	14
Ulceration	0	4	3
Claudication	7	2	0
Overall	11	6	16

the DTAI was less than 0.6, major amputation was the outcome in 48 percent, or almost half the patients. With the low index value, improvement occurred in only 33 percent of the patients.

DISCUSSION

The present study has demonstrated that lumbar sympathectomy can be expected to have a successful outcome in many patients who have acceptable inflow in the popliteal artery at the above-knee level. The purpose of this noninvasive test is to enable the physician to improve the prediction of success following sympathectomy. The Doppler DTAI provides a criterion on which to improve accuracy for predicting patient outcome following lumbar sympathectomy. In patients with a variety of limb-threatening conditions, we have found that major amputation was avoided 86 percent of the time when the DTAI was 0.6 or greater. These results, together with information on outcomes for other alternative treatments, provide further support for the selection of patients by DTAI for lumbar sympathectomy as first reported by Plecha, et al. (16). The results of the present study complement our previous report of Doppler ankle/arm systolic pressure index and other noninvasive techniques (11). The ankle/arm systolic pressure index, as previously reported, is not as sensitive a predictor as the DTAI test reported here. In animal studies, May, DeWeese, and Rob (17) have demonstrated the importance of acceptable inflow at the level of the popliteal artery, by showing that the removal of a proximal "critical" stenosis increased the response to lumbar sympathectomy. Similar results have been reported clinically by Collins, et al. (1) and Lee, et al. (18,19).

There have been conflicting reports in the literature concerning the effect of lumbar sympathectomy on severe claudication. A report by DeBakey, Creech, and Woodhall (20) found 86 percent of patients with intermittent claudication had a beneficial outcome after lumbar sympathectomy. In contrast, Mavor (21) reported an 83 percent failure rate. Although there were relatively few patients (n = 22) with severe disabling intermittent claudication in this study, 77 percent of these patients had a beneficial outcome following lumbar sympathectomy.

As previously reported, our group has had a good experience with lumbar sympathectomy. In a retrospective review of 45 patients with toe gangrene not amenable to direct arterial surgery and managed with lumbar sympathectomy (5), we found a 5-year cumulative limb salvage rate of 71 percent and a cumulative limb salvage rate of 51 percent at 8 years. In another, earlier report of 100 patients with lower extremity gangrene (4), a limb salvage rate of 75 percent was seen in 57 limbs with toe gangrene. With foot gangrene, however, this percentage dropped precipitously to 38 percent.

Good clinical judgment is still required when the noninvasive vascular diagnostic techniques are applied. Patients with extensive tissue necrosis and uncontrolled infection will not benefit from lumbar sympathectomy. Noninvasive predictive criteria used in conjunction with good clinical judgment will

provide appropriate use and refinement of the role of lumbar sympathectomy.

SUMMARY

A retrospective review of 90 lumbar sympathectomies has been carried out to examine the role of a distal thigh/arm systolic pressure index in predicting the outcome for patients who may undergo lumbar sympathectomy. Overall, a favorable result following lumbar sympathectomy (relief of symptoms or prevention of major amputation) was seen in 73 percent of the patients. In patients with a DTAI of 0.6 or greater, the rate of improvement was 70 percent, while in those with low DTAI, the rate was only 33 percent. Major amputation was avoided in 86 percent of the patients. When the DTAI was less than 0.6, major amputation was the outcome in 48 percent of patients. Based on these results, we believe that a DTAI of greater than 0.6 is a suitable criterion for guidance in selecting patients who will have a beneficial outcome after sympathectomy.

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