

## Field comparison of 10-g and 1-g filaments for the sensory testing of hands in Ethiopian leprosy patients

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*Summary* In ALERT's leprosy control programme sensory testing of hands and feet is done with a nylon filament giving a 10-g stimulus, but doubts arose that early partial sensory loss in hands would not thus be discovered. In order to evaluate the relative performance of 1-g and 10-g filaments for sensory testing on the palms of hands, both filaments were used separately in a series of 1,021 examinations on several consecutive occasions in 159 leprosy patients and 97 nonleprosy controls. The 1-g filament was always felt on normal hands and does not lead to false positive findings of nerve dysfunction. If the 1-g filament were used routinely, almost twice as many instances of 'neuritis' would be discovered and treated, if the criterion for diagnosis and treatment of new nerve dysfunction remained as it is for nerves tested with the 10-g filament.

It appears desirable to distinguish between testing for early sensory loss and for loss of protective sensation. The two tests may each need their own instrument and separate recording of the results.

### Introduction

In leprosy control programmes, sensory testing of the skin of palms of hands and soles of feet was widely introduced in the 1970s. Testing was carried out with the tip of a pencil or a ballpoint pen and the purpose was to identify any lack of protective sensation.<sup>1</sup> This test was commonly carried out a few times a year, in order to identify patients in need of health education and of provision for the protection of insensitive hands and feet (gloves, footwear).

Gradually in the late 1970s and the 1980s more attention was drawn to the role this sensory testing could play in the detection and monitoring<sup>2,3,7,8</sup> of new or additional loss of sensation, particularly when occurring insidiously without other obvious signs of leprosy reaction, in what has been termed 'silent neuritis'.<sup>4</sup>

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Consequently it was suggested that the ballpoint pen should be replaced by one or more nylon monofilaments,<sup>3,5,6</sup> so that standardized and quantifiable stimuli could be used for testing. In ALERT's Physiotherapy Section, such filaments were introduced around 1980<sup>6,9</sup> and in the leprosy control field clinics the ballpoint was replaced by a single nylon filament in 1989. The one filament chosen for use in the field clinics gives a standard stimulus of 10 g. Since then this '10-g filament' has been used for the testing of both palms and soles.

Because of the differences in sensitivity between hands and feet, and of the possible influence of differences in the thickness of skin (particularly among people accustomed to walking barefoot), it would appear desirable that different calibres of filament should be used. On the other hand, it was not considered operationally feasible for field workers to use more than one filament reliably, and so the 10-g filament alone was chosen as a compromise.

Subsequently some patients were found to be complaining of numbness in the palm despite normal responses to testing with the 10-g filament. This suggested that the 10-g filament did not provide a sufficiently sensitive test for early sensory loss in the hand.

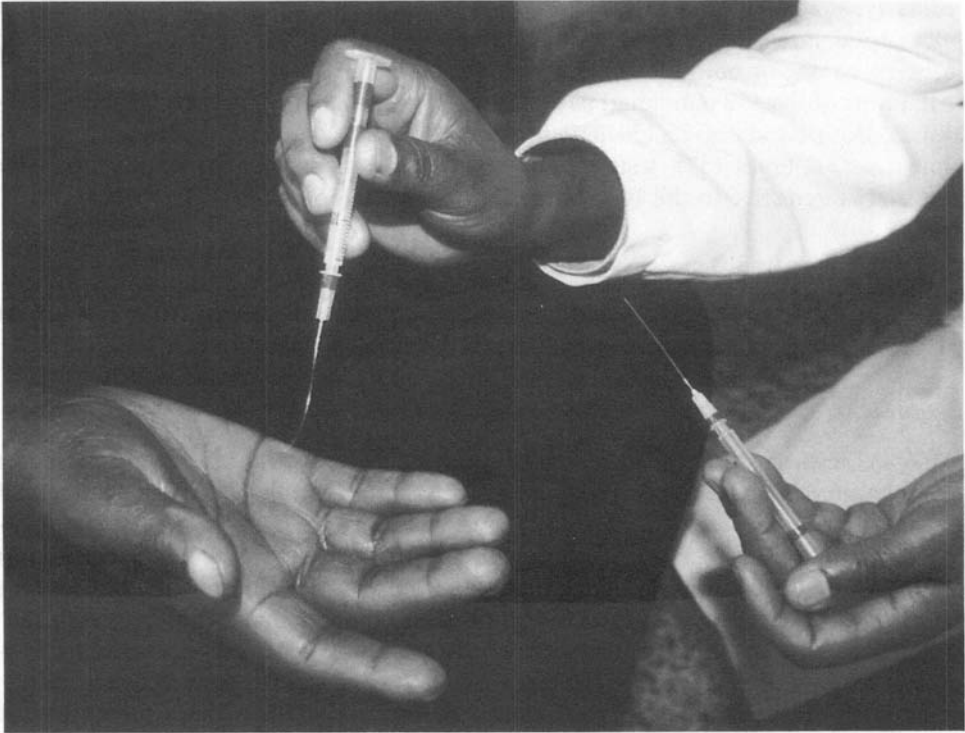
This study was therefore initiated to establish whether, for the hand, a finer filament could reliably be used in the field, and to investigate if its use might facilitate the earlier detection of neuritis. This could possibly contribute to the improvement of disability prevention by indicating treatment for neuritis at an earlier stage of disease.

## Methods

In the context of the AMFES project, carried out by ALERT, Ethiopia,<sup>10,11</sup> sensory testing of the hands of leprosy patients was carried out longitudinally using 10-g filaments. For these tests, a nylon monofilament is mounted in the cut-off shaft of a hypodermic needle of suitable size which then, for use, is placed on the nozzle of a disposable 1-ml syringe. When not in use, the syringe (from which the piston has been removed) serves as a protective casing for the filament, giving a small instrument that can easily be carried by field workers (Figure 1). To carry out a test, the end of the filament is pressed perpendicularly against the skin until it buckles, exerting a standard force.

In both hands, 6 points on the skin of the palm area served by the median nerve and 4 points for the ulnar nerve were tested at standard sites on each occasion. After patients had been familiarized with the testing method, response to the 1-g stimulus was usually tested first and thereafter the 10-g filament was applied. Hands feeling the 1 g at all sites did not need to be tested with the 10-g filament. Findings were recorded on a special sheet which was removed from the patient file and stored elsewhere before the next examination 4 weeks later. These examinations were carried out in 38 leprosy clinics of 3 districts. In all, 9 health assistants and 6 supervisors participated. Most of the examinations were carried out by health assistants (HAs). Per patient the sequential tests at 4-weekly intervals were usually done by the same person. The HAs were instructed to ask the visiting leprosy control supervisor to repeat the testing in cases where any finding for the 1-g filament differed from those for the 10-g filament, but the HA was not to show his findings. These repeat tests of the same patient on the same occasion, and also those at periodical supervisor's reviews of patients, were done for interobserver comparison.

In all, 159 leprosy patients were involved. These were ambulatory patients, 41



**Figure 1.** Testing sensitivity of the hand using a 10-g filament, mounted in a cut-off hypodermic needle attached to an empty disposable syringe, which acts as a protective cover for the filament when not in use. The alternative 1-g filament is also seen.

paucibacillary and 117 multibacillary, treated with WHO-MDT. The tests were done at the 4-weekly collection of their MDT drugs. (A few patients had also some follow-up tests done during surveillance after completion of the MDT course.)

Findings with the 1-g filament had no consequences for patient management. New sensory loss found with the 10-g filament at 2 or more points of the same nerve area made a patient eligible for an intervention with prednisolone. Tests with the 2 filaments were then continued, often every 2 weeks, to monitor the response to the antireaction treatment.

In addition to these examinations of leprosy patients, a randomly selected group of 97 nonleprosy controls from similar backgrounds were each twice tested in the same way by different examiners, using 10-g and 1-g filaments. These controls consisted of 58 persons who attended a rural health clinic, for other reasons than leprosy, and 39 manual labourers on a building site. This latter group was added to ensure that the control group contained enough men with hands well exposed to manual labour. Age and gender distribution and living conditions of patients and controls were closely similar.

## Results

### LEPROSY PATIENTS

A total of 1,021 examinations were done on 159 patients. In 563/1021 tests (55.1%) total

sensitivity, at all 10 sites of both hands, to the 1-g filament was recorded, and in 20 tests (2.0%) total insensitivity to the 10-g filament was recorded. Thus a partial loss of sensitivity to one or both filaments was found in 438 tests.

In terms of the 159 individual patients, the mean number of tests per patient was 6.4 (sd 4.2). Both hands of 75/159 patients (47.2%) were completely sensitive to the 1-g filament at all times (375 tests in all), and of 5 patients (3.1%) both hands were completely insensitive to the 10-g filament throughout (15 tests).

#### NONLEPROSY CONTROLS

Of the 97 nonleprosy controls tested in the same way, the only insensitivity recorded was in 1 point, in 1 person's hand, by 1 observer, for the 1-g filament.

#### COMPARISON OF 1G AND 10G RESULTS

Of the 438 tests showing some (but not total) loss of sensitivity, the records of 6 were incomplete and have been excluded from further analysis, leaving 432 tests relating to 79 patients.

The overall results 'per nerve' are summarized in Table 1. Clearly the individual tests (columns 1 and 3) cannot be considered statistically independent of the patients and nerves to whom they relate. Therefore, statistical comparisons of findings with the 2 filaments were made only for frequencies of insensitivity per nerve (columns 2 and 4). Similar patterns of insensitivity for the 1-g and 10-g filaments were observed in all 4 nerves, with the right ulnar nerve showing the highest extent of insensitivity to both filaments. Overall, the tests using the 1-g filament revealed significantly more insensitive nerves than those using the 10-g filament. For the left ulnar nerve the difference was not significant in this series.

The incidence of sensory loss in hands is high in these 79 patients. For the standard 10-g filament, some loss was found in 163 (51.6%) of the 316 ( $4 \times 79$ ) nerves tested and for the 1-g filament this proportion reached 70.9% (224/316). In Table 2, the results of the same tests are presented on the basis of a comparison within each test. In over half of the tests, equal insensitivities were recorded for both filaments. In most of the remaining

**Table 1.** Specification of 432 sensitivity tests in 79 patients in the AMPES project, which showed any loss of sensitivity for either the 1-g or the 10-g filament, or for both. Numbers of tests and nerves with sensory loss are given per nerve and per filament. Comparison (with  $\chi^2$ -squares) is shown for the proportions of nerves with sensory loss, as found by the 2 filaments

	1-g filament		10-filament		Comparison	
	tests [1]	nerves [2]	tests [3]	nerves [4]	$\chi^2$	<i>p</i>
N	432	79	432	79		
Right median	266	58	152	39	8.65	0.003
Right ulnar	321	61	209	43	8.13	0.004
Left ulnar	248	52	160	42	2.13	n.s.
Left median	265	53	155	39	4.40	0.036
(4 nerves)	(224)		(163)		(24.00)	< 0.001)

**Table 2.** Comparisons of 432 sensitivity tests on the hands which showed any loss of sensitivity to either 1-g or 10-g filaments. The results are categorized by differences between the 2 filaments. The tests relate to 79 patients in the AMFES project. Percentages are shown in parentheses

	1 g showing higher insensitivity	1 g and 10 g showing equal insensitivity	1 g showing lower insensitivity
Right median	185 (42.8)	241 (55.8)	6 (1.4)
Right ulnar	178 (41.2)	253 (58.6)	1 (0.2)
Left ulnar	147 (34.0)	281 (65.0)	4 (0.9)
Left median	194 (44.9)	236 (54.6)	2 (0.5)

tests, additional insensitivity was revealed using the 1-g filament. Only a very small number of tests showed less insensitivity using the 1-g filament, of which most may be due to procedural errors.

#### INTEROBSERVER VARIATION

In Table 3, the proportions of 429 tests showing any degree of sensory loss, by filament and category of observer, are presented. HAs carried out 289 tests and supervisory staff 140. (For 3/432 tests, the examiner was not identified.) For all four nerves, using both filaments, percentages of insensitivity detected by HAs and supervisors were within approximately 5% of the overall proportion. For 3 of the 4 nerve areas tested the supervisors found slightly less sensitivity than the health assistants. For the right ulnar nerve this was the opposite.

In some cases, patients were tested independently on the same day by both categories of examiner. In total, there were 98 paired observations of this kind among the 429 tests. In 45 of these pairs (45.9%), there was complete agreement on sensory loss for all 4

**Table 3.** Results of 429 sensitivity tests on the hands, using both 1-g and 10-g filaments, in which some loss of sensation was recorded, classified by examiner (health assistants (HA) or supervisory staff). These tests relate to 79 patients in the AMFES project. Percentages are shown in parentheses

	1-g filament			10-g filament		
	HA	[all]	supervisor	HA	[all]	supervisor
Number of tests	289		140	289		140
Right median	185 (64.0)	[61.5]	79 (56.4)	109 (37.7)	[35.2]	42 (30.0)
Right ulnar	211 (73.0)	[74.3]	108 (77.1)	136 (47.1)	[48.7]	73 (52.1)
Left ulnar	172 (59.5)	[57.6]	75 (53.6)	111 (38.4)	[37.1]	48 [34.2]
Left median	182 (62.9)	[61.5]	82 (58.6)	106 (36.7)	[35.9]	48 (34.3)

nerves, using both filaments. In 7 cases (7.1%) the observers differed only for findings with the 10-g filament; in 26 cases (26.5%) they differed only for the 1-g filament, and in 20 cases (20.4%) they had differences for both filaments.

#### LONGITUDINAL ANALYSIS

From the overall group of patients, those 47 for whom 3 or more examinations were completed on different dates over a period of 3 months or longer, and in whom some insensitivity was recorded at least once, have been selected for longitudinal analysis of changing patterns of sensory loss to both 1-g and 10-g filaments. A total of 325 tests were performed on these patients. In cases where 2 examinations were carried out on the same patient on the same day, the one performed by the more senior examiner has been used.

In 46/47 patients, additional insensitivity was revealed using the 1-g filament on at least one occasion. For each nerve, for each patient, it is possible to categorize the overall pattern of insensitivity to testing with 1-g and 10-g filaments as follows:

- A: nerves with any insensitivity to either filament;
- B: some insensitivity to 1 g, but never to 10 g;
- C: periods of insensitivity to 1 g, but not to 10 g, before and/or after periods of insensitivity to both filaments;
- D: some insensitivity to both filaments throughout; and
- E: a pattern different from any of the above

The results of these categorizations for the 47 patients in this analysis are shown in Table 4. Categories B and C together represent additional sensory loss detected by the use of the 1-g filament, and account for about half of the patients, for all nerves.

#### EXTRAPOLATION TO PATTERNS OF INTERVENTION

From the above longitudinal analysis, it is possible to investigate the potential consequences of the choice of filament on interventions. If an arbitrary criterion for

**Table 4.** Longitudinal analysis of 47 patients in the AMFES study for whom sensory testing with both 1-g and 10-g filaments was performed on 3 or more separate occasions over at least one occasion. Results for each nerve in each patient are categorized by patterns of sensitivity observed with both filaments over time. Percentages for each category, for each nerve, are shown in parentheses

Category	A	B	C	D	E
Nerve					
Right median	11 (23.4)	15 (31.9)	8 (17.0)	9 (19.1)	4 (8.5)
Right ulnar	9 (19.1)	15 (31.9)	9 (19.1)	12 (25.5)	2 (4.3)
Left ulnar	15 (31.9)	8 (17.0)	9 (19.1)	12 (25.5)	3 (6.4)
Left median	15 (31.9)	8 (17.0)	14 (29.8)	5 (10.6)	5 (10.6)

- A: never any insensitivity to either filament;
- B: some insensitivity to 1 g, but never to 10 g;
- C: periods of insensitivity to 1 g, but not to 10 g, before and/or after periods of insensitivity to both filaments;
- D: some insensitivity to both filaments throughout; and
- E: a pattern different from any of the above.

intervention with prednisolone is taken to be an increased loss of sensation at 2 or more points on 1 or more nerves, then with the use of the 10-g filament, 19/47 patients (40.4%) had 1 or more indications for intervention. Using the 1-g filament, 32/47 patients (68.1%) had 1 or more indications. The criterion was never met by 13/47 patients (27.7%). The mean number of indications per patient was also higher using the 1-g filament (1.25, sd 1.2) than with 10g (0.72, sd 1.1). Thus the overall effect of hypothetically using a 1 g filament instead of 10 g, would have come close to doubling the number of interventions, in this group of patients. Overall, 15 patients (31.9%) did not meet the criterion with a 10-g filament, would have been treated with the use of 1 g. Four other patients (8.5%) had additional indications for treatment using a 10-g filament while not for the 1g, but these were seriously impaired cases who had prolonged periods of total insensitivity to the 1-g filament.

## Discussion

The finding that the hands of 75 of these 159 leprosy patients were fully sensitive to the 1-g filament in all (376) tests, we consider to be evidence that a 1-g stimulus can be felt by normal hands. This was confirmed by the full response to 194 tests in 97 nonleprosy patients. From these findings we conclude that sensory loss to the 1-g filament indicates a real sensory impairment. This specificity of the 1-g filament as a tool for sensory testing of palms of hands is further supported by the 187 tests (563–376) in which both hands were found fully sensitive to the 1-g filament, in patients who at other times had a nerve function impairment with sensory loss to 1 g (or to both 1 g and 10 g).

In cases with any insensitivity, the fact that sensory loss to 1g occurred in 61 more nerves than for the 10-g filament (an increase from 51.6% to 70.9%), indicates that the 1-g filament is a more sensitive instrument for the (early) detection of sensory loss in hands.

Interobserver variation was considerable, both for the 10 g and the 1-g filament and, not surprisingly, it was more so for the latter. Workers experienced in this kind of sensory testing will know that such differences may occur even when the same examiner repeats an examination within the same session on the same day. To some extent this is a characteristic of these tests, which are quite vulnerable to several influences.

Approximately twice as many interventions with prednisolone would have been indicated if the response to the 1-g filament had been taken as criterion in the same way as it is presently done for the 10-g filament. While this study does not allow any conclusions regarding the possible therapeutic effect of using this more sensitive criterion for initiating neuritis treatment, it is possible that it would be of benefit to patients.

As our study also indicates that the use of a 1-g filament would not lead to any significant proportion of false positive signs of nerve dysfunction, we conclude that for early detection of sensory loss to light touch on the palms of leprosy patients, the 1-g filament is an appropriate tool. With this filament, it should be possible to detect insidiously developing neuritis earlier than by using a ballpoint pen or a 10-g filament.

An important further concept is that, in the sensory testing of hands and feet, carried out now in so many leprosy control programmes, there are two distinct objectives:

- (1) the *early detection of (insidious) neuritis*, for which a medical intervention would be indicated; and for monitoring the response to neuritis treatment. For this a sensitive instrument, providing a constant stimulus, is needed, but this test

should still be specific enough not to give false positive findings of nerve dysfunction; and

- (2) the assessment of *loss of protective sensation*, i.e. the level of sensory loss that puts a hand or foot at risk for wounds, burns, etc. and consequent damage. This requires a much stronger stimulus.

Programmes should therefore address these two objectives separately. In addition, the level of stimuli required for (1) and (2) may differ between palms and soles of feet.\* Whilst this approach to sensory testing would have considerable operational consequences, involving several instruments and revised methods of recording, we nevertheless believe it to be justified.

In our programme we now therefore recommend using a 1-g filament for the hands for objective (1), and a ballpoint pen for objective (2).

### Acknowledgments

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\* Alert's studies on the testing of feet are not yet concluded.