

Reporting numerical values for sensory testing

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Introduction

Two methods for measuring tactile sensation in the skin are in common clinical use by surgeons: two-point discrimination (2PD) and monofilament testing. It is not our purpose to describe in detail how to carry out these tests, but to highlight some points to be considered when reporting their results in this Journal.

Two-point discrimination (2PD)

This test of tactile perception is used to assess the ability to distinguish between one or two points when two separate points are applied simultaneously to the skin. It has been widely condemned because of the large variability in reported results, particularly after nerve repair, its poor test–retest reliability and because the results are sometimes incompatible with the anatomical spacing of the relevant sensory receptors (Ludborg and Rosén, 2004). These criticisms emphasize that the test is a poor method for assessing true spatial discrimination. Nevertheless, it remains popular in clinical use because it is relatively simple to carry out, unlike more reliable investigations; these include the grating orientation test (GOT), which requires special equipment appropriate for use in research laboratories (Zhang et al., 2005), or the method of two-point orientation discrimination (2POD; Tong et al., 2013), which is more difficult to carry out in the clinic than 2PD and has not been widely adopted.

2PD can be tested by using the traditional untwisted paper clip, a calliper (either calibrated or not) or a purpose-designed instrument such as the Baseline™ two-point discriminator wheel (Fabrication Enterprises, White Plains, NY, USA). Whatever device is used, the two points are applied simultaneously to test either static or moving 2PD (s2PD and m2PD, respectively). The latter depends on fast-adapting sensory fibres, which recover more quickly after nerve repair than the slowly adapting sensory fibres that detect static discrimination; m2PD is able to detect two points that are closer together than can be detected with s2PD (Dellon, 1978).

The separation of the tips of an untwisted paper clip can be measured with a ruler or Vernier calliper and should be set in increments of 1 mm, although it is unlikely that separations set with a ruler will be precise. The two points on proprietary discriminator wheels are fixed, with separations from 2 to 8 mm on one disk and 9 to 15 mm on another, both with increments of 1 mm. The points are so arranged that additional 20- and 25-mm separations can be obtained. When recording the results of examinations for 2PD in a series of patients, the mean value (if the distribution is normal) of the individual results should be rounded to the nearest whole millimetre to avoid spurious precision. The standard deviation and range should also be given. Data that are not normally distributed should be presented with a rounded median value, together with the interquartile range (IQR) and the range.

Reporting results

When reporting the results of 2PD in articles submitted to this Journal, the following information is required.

- Who did the test? (To allow identification of possible observer bias.)
- At what point was the test done during follow-up?
- The instrument that was used must be described clearly.
- Was s2PD or m2PD tested? Or both?
- Mean values should be rounded to the nearest whole millimetre and presented with the information mentioned above, depending on the distribution of the data.

Monofilament testing

Although commonly referred to as Semmes-Weinstein (S-W) filaments, modern monofilament instruments use different materials from those used in the original S-W monofilaments. Monofilament instruments are rods with filaments of various thicknesses mounted at 90° to each rod.

In contrast to the spatial discrimination tested by 2PD, they are used to detect the amount of force applied to the skin; the receptors for detecting sensation and force are different. The force (often loosely termed ‘pressure’, which is force per unit area) applied by a given filament is a function of its thickness; a thick monofilament is stiffer than a thin one. The filament is applied perpendicular to the skin until it bends, and the value is recorded as the smallest number of the fibre that the patient can feel. The monofilament should *not* be allowed to move on the skin to avoid stimulation of tactile sensory receptors. Unlike the 2PD test referred to above, monofilament tests have relatively good reliability (Bell-Krotoski and Tomancik, 1987), although monofilaments may be affected by temperature, and their performance may deteriorate over time. Commercially available monofilament kits contain between five and 20 filaments, and the results can be presented in various categories (Table 1). The commonly used five-piece set is often colour-coded, as shown in Table 1.

It is important to understand that an individual filament number does not represent the physical diameter of the filament; nor is it a direct value for the force applied. The filament numbers (1.65 to 6.65) are based on a logarithmic scale for

the forces that they apply (0.008 to 300 g). The formula is:

$$\text{Filament number} = \text{Log}_{10}(10 \times \text{force in mg})$$

Thus, the forces applied by the 1.65 and 6.65 filaments differ by a factor of 37,500. Some confusion has arisen from the way that filaments are numbered, which can cause problems when presenting the results of monofilament testing from a series of patients.

Presenting individual filament numbers

As individual filament numbers are based on a logarithmic scale, it is not appropriate to simply divide the sum of the filament numbers obtained from each patient by the number of patients in the series to obtain a mean value, although some have done this (Arik et al., 2021). In this situation, the modal (most frequently occurring) value should be given, along with the range.

Presenting forces applied by individual fibres

If the results are presented as the forces applied by individual fibres, then it is acceptable to present the

Table 1. Characteristics of monofilament fibres.

Fibre number	Target force applied in grams	Colour	Threshold category	Grade			
1.65	0.008	Green	Normal	5			
2.36	0.02						
2.44	0.04						
2.83	0.07						
3.22	0.16	Blue	Diminished light touch	4			
3.61	0.4						
3.84	0.6	Purple	Diminished protective sensation	3			
4.08	1						
4.17	1.4						
4.31	2						
4.56	4	Red	Loss of protective sensation	2			
4.74	6						
4.93	8						
5.07	10						
5.18	15						
5.46	26						
5.88	60						
6.10	100						
6.45	180						
6.65	300				Red lines	Deep pressure sensation only	1

result with a mean value rounded to the nearest whole number, if they are normally distributed, together with the standard deviation and range. Data that are not normally distributed should be presented as a rounded median value with IQR and range.

Presenting other categories

Other categories (colour, threshold and grade) should be presented as modal values with the range.

Presenting the results graphically

An alternative is to present the results as a bar chart, with the categories on the X-axis and the number of patients in each category on the Y-axis.

Reporting results

When reporting the results of monofilament testing in articles submitted to this Journal, the following information is required.

- Who did the test? (To allow identification of possible observer bias.)
- At what point was the test done during follow-up?
- How are the results presented (as filament numbers, pressure applied, colour, threshold category or grade)?
- The advice given above should be followed when presenting the results obtained using the possible categories.

In conclusion, although clinical sensory testing presents some difficulties, it is useful for comparing the results of different surgical treatments. To enable our readership to compare the results from different articles, we prefer authors to report their results, and the way they were measured, with the details described above.

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