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Reproducibility along a 10 cm vertical visual analogue scale

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SUMMARY Reproducibility along a vertical 10 cm visual analogue scale (VAS) was investigated. Eight normal volunteers attempted to duplicate a set of marked VASs. There was a tendency to estimate too high on the scale, and reproducibility was found to be variable along its length. This indicates that the error involved in the use of VASs is even more complex than previously thought.

The complex problems relating to the use, accuracy, reproducibility, and statistical analysis of results obtained from visual analogue scales (VAS) are well recognised.[1–5] Recent work with VASs to measure pain in rheumatic patients showed a statistical advantage in making the previous result available to the patient when long-term serial assessments are being made.[6] We agree with the impression of these authors that patients feel more secure when allowed access to the previous result, but our own studies with a summated change score, based on this premise, showed it to correlate poorly with other indices of change.[7] This prompted us to return to a 10 cm vertical VAS and consider the reproducibility of repeated exposure to this scale.

If a patient claimed equivalent pain on consecutive occasions and had access to the initial result, would the error involved in reproducing the initial result be the same along the length of a 10 cm VAS? It would seem likely that reproducibility near the apices might be better than for more central points.

Scott and Huskisson[6] showed that there was a tendency to overestimate pain severity when the initial result was not available, but would this tendency alter when initial results were made available?

Materials and methods

Eight normal volunteers (4 male, 4 female, age range 18–49 years) were each presented with a series of 10 vertical 10 cm reference lines crossed at some point between the apices A and B (Fig. 1). The randomnly selected distance from the end (D cm) at which each line was crossed is shown in Table 1. Having looked at one reference line, each volunteer was then asked to duplicate the position of the cross on a

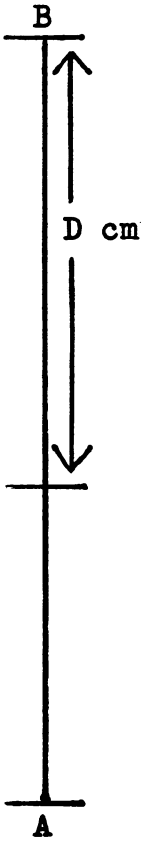

Fig. 1 *Example of a reference line (actual size).*

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Table 1 *Performance of 8 volunteers in reproducing 10 different completed VASs*

Actual distance (D cm)	*Number of estimates (× cm) falling*		
	Short (x< D)	*Equal (x=D)*	*Long (x>D)*
1·00	32	8	16
2·00	51	2	3
3·00	52	1	3
4·60	33	7	16
5·00	53	1	2
5·50	35	5	16
6·00	17	1	38
7·50	12	6	38
8·20	14	3	39
9·50	37	14	5

blank 10 cm line. This operation was repeated a further 6 times for the given reference line for each volunteer. Successive reference lines were presented in a random order. The distance from B to the estimated cross (x cm) was measured (± 0·5 mm) on every line, and the distance was compared with the actual distance of the cross on the reference line (D cm).

Results

Eight volunteers each attempting to duplicate 10 different reference lines 7 times each gave a total of 560 measurements, of which 60·0% were short that is, x<D), 8·6% were correct (x=D), and 31·4% were long (x>D). These observations are summarised in Table 1.

The standard deviation on the 56 estimates for each of the ten D values varied, and the most consistent estimates were for those near the apices and at the midpoint (Table 2). However, whereas the estimates near the apices were also the most accurate (that is, the mean of the 56 estimates ($\bar{x}$ cm) was close to D cm), the estimates for the midpoint were less accurate and invariably short (53 short, 1 equal, 2 long) (Tables 1 and 2).

Table 2 *Variation in reproducibility along the length of a VAS*

Actual distance (D cm)	*Mean estimate ($\bar{x}$ cm)*	*D — $\bar{x}$ (cm)*	*Standard deviation*
1·00	0·98	0·02	0·090
2·00	1·81	0·19	0·119
3·00	2·65	0·35	0·224
4·60	4·53	0·07	0·248
5·00	4·80	0·20	0·127
5·50	5·41	0·09	0·291
6·00	6·19	−0·19	0·321
7·50	7·64	−0·14	0·170
8·20	8·31	−0·11	0·176
9·50	9·43	0·07	0·089

It was of interest that there was a swing from estimating short to estimating long which occurred at D=6·00 cm (Table 1), and that the mean of the estimate ($\bar{x}$ cm) for this distance was 6·19 cm (Table 2) which corresponds to the golden section.[8]

Discussion

It is clear from the results that reproducibility along a vertical 10 cm VAS varies along the length of the line. The most difficult positions to reproduce appear to be in the region ± 2 cm of the midpoint with good reproducibility occurring near the apices and at the centre. In connection with this it is interesting to note that patients using VASs to estimate their degree of pain have a tendency to estimate towards the extremities or the centre. This suggests that patients can only visualise their pain as mild, severe, or somewhere vaguely inbetween.

The tendency we found to estimate positions too high on a vertical VAS when access to the initial reference line was available was even more pronounced than observed by Scott and Huskisson[6] for patients who did not have access to their initial result. However, this assumes that the most 'severe pain' was represented by the top of their scale (B), and 'no pain' was at the bottom (A).

For vertical VASs there is an additional source of error not present for horizontal VASs, namely, the angle at which the scale is viewed. A vertical scale should be viewed vertically to avoid error resulting from perspective. Such an error may contribute to the present results, though we tried to ensure that the volunteers viewed the scales from a vertical position. However, in the busy clinic where the patient may be sitting to one side of the assessor, this may represent a source of error that is not usually appreciated.

We are unable to explain why patients tended to estimate short above a point 6·19 cm along a 10 cm line and long below it, but we note that psychologists since antiquity have recognised the 'golden section' as that point on a line which divides it into 2 segments such that the smaller is to the larger as the larger is to the whole line, and which can be shown to be approximately 62% of the way along its length. Benjafield and Adams-Webber[8] showed that when subjects have to make bipolar estimates, as on VASs, the ratio of those choosing positive to those choosing negative is an approximation of the golden section. This corresponds to our results with 60% of estimates being short and 31% long with the turning point occurring at the golden section itself.

While our results suggest that the theory behind analysis of VASs remains little understood, we also

feel that patient compliance and inadequate explanation remain greater sources of error. It could also be argued that VASs may still express what the patient thinks they ought to feel rather than what they actually feel and hence may not be a substitute for an objective assessment of pain.

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