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Utility and validity of a single-item visual analog scale for measuring dental anxiety in clinical practice

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Abstract: We evaluated whether a visual analog scale (VAS) was comparable to the multi-item Modified Dental Anxiety Scale (MDAS) in assessing dental anxiety in clinical practice. In total, 200 consecutive patients aged 20-70 years who presented at the dental outpatient department of SRM Dental College, Chennai were enrolled. The test-retest value for the VAS was 0.968. The Spearman rank correlations between the VAS and MDAS items and total score were significant ($P < 0.001$). The Spearman rank correlation between postponement of a dental visit and the VAS also showed a strong correlation ($r = 0.473$, $P < 0.001$). On linear regression analysis, the coefficient of determination showed a strong relationship between the two variables; the MDAS accounted for 74% of the variation. The regression coefficient was statistically significant ($P < 0.001$). On the basis of receiver-operating-characteristic curve analysis, a VAS cut-off value of ≥ 4.8 was selected to discriminate between patients who were and were not anxious, and a cut-off value of ≥ 7 was selected to identify patients with dental phobia. The weighted kappa was 69% for agreement between MDAS and the VAS in identifying patients with and without dental anxiety at cut-offs of 13 and 4.75, respectively. The VAS was found to be a valid measure and was comparable to the multi-item MDAS. (J Oral Sci 56, 151-156, 2014)

Keywords: visual analog scale; dental anxiety; Modified Dental Anxiety Scale; reliability; validity; receiver operating curve.

Introduction

Dental anxiety is a common concern in dental practice. Available assessment tools for measuring anxiety include the Corah Dental Anxiety Scale, Modified Dental Anxiety Scale (MDAS), Dental Concerns Assessment, Dental Anxiety Inventory, Dental Fear Survey, State-Trait Anxiety Inventory (STAI), General Geer Fear Scale, and Getz Dental Belief Survey.

Most anxiety evaluation tools have multiple questions with Likert-scale scoring. Administration of multi-item questionnaires has several disadvantages: busy clinical practices have time constraints; responses on a self-administered multi-item questionnaire might depend on individual interpretation and perception; less educated or uneducated people might not be able to read or comprehend the questions and may thus require trained interviewers; some patients might regard a long questionnaire as irrelevant or unnecessary, particularly when they are suffering from severe pain; too few or too many responses might confuse a respondent; some complex continuous subjective behaviors cannot be explained in categorical terms; and information on scale items might be lost when scores are summed, which can lead to incorrect conclusions (1-3).

The single-item visual analog scale (VAS) is simple and widely used in psychosocial measurement to assess subjective phenomena. It is easier to administer, faster, and less burdensome for patients and results in high response rates. It was described and used by Aitken in 1969, popularized for measurement of pain by Huskisson (4), and shown to be reliable, valid, and highly respon-

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sive. Epidemiological and clinical studies extensively utilize the VAS to measure subjective experiences like pain, panic, depression, health states, tension headache, fatigue, anxiety, psychological distress, quality of life, and worry. It takes less than 1 min to complete (5). The VAS is usually presented as a 10-cm horizontal line, with each end-point clearly marked. Subjects are asked to mark the point on the line that represents how they feel about the phenomenon at that time. The distance from one end of the line to the participant's mark is measured and provides a quantitative variable that can be used in statistical analysis. Many variants of the VAS have been used by researchers, and it can be presented in a number of ways, such as scales with a midpoint, graduations, or numbers along the line, meter-shaped scales, box scales (with numbers placed in squares), scales consisting of equidistant circles, and scales with descriptive terms at both ends and at intervals along the line. When numbers are added to the line, without vertical marks to indicate boundaries, it is called a graphic rating scale (6,7).

We evaluated a VAS in clinical practice as a single measure to assess anxiety before a dental procedure and compared the finding with those obtained with the MDAS.

Materials and Methods

This observational, cross-sectional study was conducted from November 2012 through January 2013 in the Outpatient Department of Periodontics at SRM Dental College, Chennai as a part of ongoing research on dental anxiety. Ethical clearance was obtained from the institutional ethical committee (SRMU/M&HS/SRMDC/2012/MDS-STAFF/001). Convenience sampling was used to recruit 200 consecutive patients aged 20-70 years who presented at the regular dental outpatient department. The participants had various dental complaints, such as decayed teeth, missing teeth, poor dental esthetics, impacted teeth, and tooth pain. We excluded patients with acute dental pain, psychiatric disorders, or generalized anxiety disorder, those receiving antidepressants, and those who declined to give informed consent.

Patients were asked to complete a questionnaire in the waiting area, before they were examined. The questionnaire asked about demographic data and dental history and included the MDAS and VAS, to measure anxiety. The validated Tamil version of the MDAS was administered (8). The questionnaire was structured to evaluate anxiety in five situations. The questions were as follows: "If you went to your dentist for treatment tomorrow, how would you feel?", "If you were sitting in the waiting room (waiting for treatment), how would you feel?",

"If you were about to have a tooth drilled, how would you feel?", "If you were about to have your teeth scaled and polished, how would you feel?", and "If you were about to have a local anesthetic injection in your gum, above an upper back tooth, how would you feel?". Each question had five responses, which were scored from 1 to 5, where 1 represented not anxious and 5 represented extremely anxious. The total score of the scale ranged from 5 through 25.

A single-measure horizontal VAS scale, from 0 to 10 cm, was used. The ends were marked "not anxious at all" and "extremely anxious". Patients were asked to indicate their level of dental anxiety on the line. The distance was measured and recorded. Patients who were unable to read were assisted by interns who were trained for that purpose and were continuously available for clarification during administration of the questionnaire. To assess reliability, 30 people who had no acute dental complaints were selected to complete the VAS twice within a period of 7-10 days.

The collected data were entered on a Microsoft Excel spreadsheet, and statistical analysis was performed using the Microsoft SPSS 16 software. Descriptives of the variables assessed in the history form were calculated. The reliability of the VAS was assessed using the Cronbach α and intraclass and inter-item correlations. Spearman rank correlations were used to assess the strength of the relationship between tests. MDAS total score was used as the predictor variable and VAS as the outcome variable in linear regression analysis. Receiver-operating-characteristic (ROC) curve analysis was used to calculate sensitivity and specificity at various VAS cut-off points.

Results

Among the 200 patients who agreed to participate in the study, 68% were men and 32% were women. Mean (SD) age of the participants was 31.92 (12.49) years (median, 28). Among the respondents, 88.5% were 20-50 years of age and 11.5% were older than 50 years. Overall, 2.5% of the participants had no formal education, and 62% had a college degree or more education. Among the 200 participants, 24.5% were unemployed, 58% were employed, 14.5% were studying in college, and 3% had retired from work. Analysis of financial status showed that 39% of the patients had no income and were financially dependent on other members of the family, 27.5% earned <10,000 Indian rupees per month, and 33.5% earned >10,000 Indian rupees per month. Oral health was perceived as excellent or good by 52% of participants, average by 42%, and poor by 6% of participants. Only 65% of the 200 respondents had visited a dentist at least

Table 1 Descriptive statistics, reliability of VAS and Spearman correlation between variables

Mean, median, and standard deviation of age, items in MDAS and VAS								
	Age	Q1	Q2	Q3	Q4	Q5	MDAS	VAS
Mean	31.92	1.7	1.66	2.31	1.61	2.38	9.66	2.53
Median	28	1	1	2	1	2	9	2
Standard deviation	12.49	0.89	0.872	1.091	0.867	1.235	3.925	2.19
Statistics for reliability of the VAS								
	Mean ± SD	Spearman correlation	Cronbach α	Inter-item correlation matrix	ICC [†]			
VAS 1	2.83 ± 2.60	0.90	0.968	0.94	0.968			
VAS 2	2.91 ± 2.78	$P < 0.001^{**}$	$P < 0.001^{**}$	$P < 0.001^{**}$	$P < 0.001^{**}$			
Spearman correlations between the VAS and individual MDAS items								
		Q1	Q2	Q3	Q4	Q5	Total score	
VAS	Spearman correlation	0.64	0.584	0.714	0.601	0.681	0.835	
	<i>P</i> value	$<0.001^{**}$	$<0.001^{**}$	$<0.001^{**}$	$<0.001^{**}$	$<0.001^{**}$	$<0.001^{**}$	
Spearman correlation between postponement of dental visit due to dental anxiety and anxiety assessment scales								
		Q1	Q2	Q3	Q4	Q5	MDAS	VAS
Postponement of dental visit	Spearman correlation	0.318	0.288	0.392	0.315	0.315	0.396	0.473
	<i>P</i> value	$<0.001^{**}$	$<0.001^{**}$	$<0.001^{**}$	$<0.001^{**}$	$<0.001^{**}$	$<0.001^{**}$	$<0.001^{**}$

VAS, visual analog scale; MDAS, Modified Dental Anxiety Scale

[†] Intra-class correlation ****** Highly significant

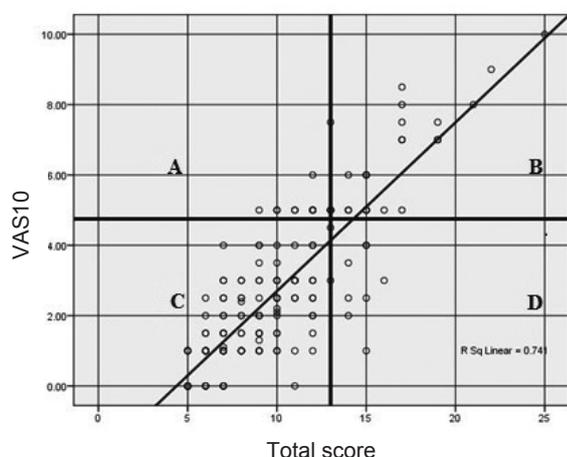


Fig. 1 Linear regression analysis of the correlation between MDAS total score and VAS score. Using an MDAS score of ≥ 13 and a VAS score of ≥ 4.75 as cut-offs for dental anxiety, the figure can be divided into four quadrants: A. area of test discordance—low MDAS is associated with high VAS; B. area of anxiety—both tests show high scores; C. area of no anxiety—both tests show low scores; and D. area of inverse test discordance—high MDAS scores are associated with low VAS values.

once before, among whom 96.2% reported a pleasant dental experience and 3.8% reported a bad experience. Overall, 12.5% of respondents had postponed their visit to a dentist due to anxiety.

Table 1 shows the mean, median, and SD of the 5

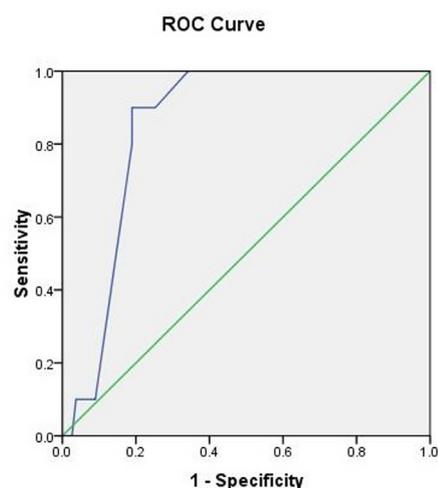


Fig. 2 Receiver-operating-characteristic (ROC) curve calculated for VAS, using MDAS as the stated variable.

items and the total scores for the MDAS and VAS. The means of the five items—Q1, Q2, Q3, Q4, and Q5—on the MDAS questionnaire were 1.7, 1.66, 2.31, 1.61, and 2.38, respectively. The mean total MDAS and VAS scores were 9.66 and 2.53, respectively. The test-retest value was 0.968. The inter-item and intraclass correlation coefficients were statistically significant ($P < 0.05$). The Spearman rank correlations between the VAS and the individual items and total score on the MDAS were statistically significant ($P < 0.001$). The Spearman rank

Table 2 Weighted kappa, PABAK and diagnostic test values for VAS

	VAS <4.75	VAS ≥4.75	Weighted kappa test	
MDAS <13	146	11	K = 0.69, $P < 0.001^{**}$,	
MDAS ≥13	10	33	95% CI (0.57-0.81)	
			PI 56.5%, BI 0.5%	
			PABAK = 0.79, $P < 0.001^{**}$	
	VAS <7	VAS ≥7	Weighted kappa test	
MDAS <19	189	4	K = 0.70, $P < 0.001^{**}$	
MDAS ≥19	3	9	95% CI (0.49-0.91)	
			PI 87.8%, BI 0.5%	
			PABAK = 0.93, $P < 0.001^{**}$	
VAS cut-off	Sensitivity	Specificity	Positive predictive value	Negative predictive value
≥4.75	0.88	0.87	0.50	0.98
≥7	0.32	0.97	0.62	0.91

VAS, visual analog scale; MDAS, Modified Dental Anxiety Scale; PI, prevalence index; BI, bias index; PABAK, prevalence-adjusted bias-adjusted kappa

** Highly significant

correlation between postponement of dental visit and VAS also showed a strong correlation ($r = 0.473$, $P < 0.001$). VAS was inversely correlated with age and income. Education, occupation, and a previous visit to the dentist were not correlated with VAS score (data not shown).

Linear regression was used to compare the outcome between the two variables, with MDAS total score as the independent variable and VAS as the dependent variable (Fig. 1). The regression equation for the model was $VAS = -2.099 + 0.48$ (MDAS total score), $r^2 = 0.741$. The coefficient of determination (r^2) showed a strong relation between the two variables, with MDAS accounting for 74% of the variation in VAS. The regression coefficient was statistically significant ($P < 0.001$).

Figure 2 shows the ROC curve calculated for VAS, using MDAS as the stated variable. An MDAS score of ≥13 (sensitivity 0.76, specificity 0.87, positive predictive value 0.43, negative predictive value 0.97) was selected as the cut-off for distinguishing patients with and without dental anxiety, and a VAS score of ≥4.75 was chosen based on a sensitivity of 88% and a specificity of 87% (area under the curve = 0.90, $P < 0.01$). The weighted kappa was 69% for the agreement between the MDAS and VAS in identifying patients with and without dental anxiety at respective cut-offs of 13 and 4.75 (Table 2). ROC analysis was performed using an MDAS cut-off ≥19 for dental phobia, and a VAS score of ≥7 was selected, as it corresponded to the best sensitivity and specificity (0.32 and 0.97, respectively). The positive predictive value was 0.62, and the negative predictive value was 0.91 (Table

2). Increasing the VAS cut-off decreased sensitivity and increased specificity. The weighted kappa was 70% for the agreement between MDAS and VAS in identifying patients with dental phobia at cut-offs of ≥19 and ≥7, respectively (Table 2). A kappa paradox was observed for both these cut-offs, (i.e., the kappa statistic was low despite high agreement). The prevalence-adjusted bias-adjusted kappa (PABAK) was used to adjust for differences in prevalence and bias (Table 2).

Discussion

We investigated the utility of a single-item VAS for measuring dental anxiety in an everyday clinical setting and found it valid and comparable to the multi-item MDAS. The VAS has been used extensively in research measuring anxiety before and after surgical procedures, and its validity for dental anxiety was first studied by Neil Luyk and colleagues in 1988. They selected 45 patients scheduled for tooth extraction and administered a VAS, Dental Anxiety Scale (DAS), and state portion (A state) of the State-Trait Anxiety Inventory before and after extraction. The VAS significantly correlated with both these instruments before and after extraction. The authors recommended using a VAS for pharmacological studies in which the patient might be sedated and could not complete a complicated questionnaire (9).

In 2011 Facco et al. (10) validated a VAS for preoperative anxiety in a study with a larger sample size. The VAS-A (Anxiety) and DAS were administered preoperatively to 1,114 patients scheduled for implants. DAS and VAS-A were strongly correlated, and the VAS-A

thresholds established for dental anxiety and phobia were 5.1 and 7.0 cm, respectively. Despite a significant concordance of 72% between the tests, disagreement was 28%. They concluded that the VAS-A was a simple, sensitive, fast, and reliable tool in assessing dental anxiety preoperatively and suggested that the rate of disagreement between VAS-A and DAS was due to varying test sensitivities to different components of dental anxiety. An extension study by the same authors in 2013 attempted to further validate a VAS by comparing it to the Corah Dental Anxiety Scale, State-Trait Anxiety Inventory, and Beck Depression Inventory and confirmed that the VAS-A was a reliable indicator of preoperative anxiety and could also detect depressive symptoms. A VAS-A value of about 50 mm was considered a reliable threshold for clinically meaningful preoperative anxiety (11).

In 2010 Williams et al. (12) evaluated the psychometric properties of a patient-reported Global Anxiety VAS (GA-VAS) for measuring anxiety in clinical trials assessing pharmaceutical treatment for generalized anxiety disorders. They reported that the GA-VAS was reliable, responsive, and valid in assessing improvement in anxiety symptoms within 1 week of beginning administration of anxiolytic drugs (12).

We found that the VAS had good reliability and stability in subsequent visits. The convergent validity of the VAS was assessed by examining correlations with the MDAS, an established scale for measuring dental anxiety. The VAS was highly correlated with total MDAS score and with scores for each item on the scale ($P < 0.001$), which indicates that the VAS, due to its unidimensional nature, was able to assess the components of dental anxiety with results similar to those of the MDAS (13). This high correlation with an established anxiety scale confirmed the findings of previous studies (8,10-12). Studies of preoperative anxiety also found a high correlation (0.62-0.84) between a VAS and the State-Trait Anxiety Inventory (11,12,14,15). In addition, studies have shown that anxious dental patients tend to postpone dental visits, and the present findings confirmed that the VAS was significantly correlated with avoidance of dental visits ($P < 0.001$), thereby establishing construct validity (8,13,16).

Regression analysis of the relationship between the VAS and MDAS showed a positive relationship. PABAK showed good agreement between tests to identify anxious and phobic participants. Among the 200 patients, disagreement between the tests was seen only in 10.5%, which was considerably less than the proportion reported by Facco and colleagues (10). Responses on the 10-cm

VAS were clustered at the lower end and middle of the scale: 91% of responses were between 0 and 5 cm, 72% of responses were clustered between 0 and 3 cm, and 13% of responses were clustered at 5 cm. According to McCormack et al., this type of rating scale displays clustering at the middle and at high and low extremes (2).

The limitations of the present study are its small sample size and the fact that the responsiveness of the VAS was not studied. Dental anxiety scales that measure multidimensional aspects are closely correlated with VAS, and it remains to be determined whether the effect is similar in this Tamil-speaking population.

In conclusion, the VAS was useful and effective in identifying patients with anxiety and dental phobia. A threshold of 4.8 cm can be used to distinguish between patients with and without anxiety. The VAS was comparable to the MDAS and can be used routinely in dental clinics before treatment procedures. However, it remains to be determined if the VAS is comparable or superior to multi-item tools in capturing all elements of dental anxiety.

References

1. McCormack HM, Horne DJ, Sheather S (1988) Clinical applications of visual analogue scales: a critical review. *Psychol Med* 18, 1007-1019.
2. Svensson E (2001) Construction of a single global scale for multi-item assessments of the same variable. *Stat Med* 20, 3831-3846.
3. Hasson D, Arnetz BB (2005) Validation and findings comparing VAS vs. likert scales for psychosocial measurements. *Int Electron J Health Educ* 8, 178-192.
4. Aitken RC (1969) Measurement of feelings using visual analogue scales. *Proc R Soc Med* 62, 989-993.
5. Downie WW, Leatham PA, Rhind VM, Wright V, Branco JA, Anderson JA (1978) Studies with pain rating scales. *Ann Rheum Dis* 37, 378-381.
6. Khan FA, Nazir S (2007) Assessment of pre-operative anxiety in patients for elective surgery. *J Anaesthesiol Clin Pharmacol* 23, 259-262.
7. Pritchard M (2010) Measuring anxiety in surgical patients using a visual analogue scale. *Nurs Stand* 25, 40-44.
8. Appukuttan D, Datchnamurthy M, Deborah SP, Hirudayaraj GJ, Tadepalli A, Victor DJ (2012) Reliability and validity of the Tamil version of Modified Dental Anxiety Scale. *J Oral Sci* 54, 313-320.
9. Luyk NH, Beck FM, Weaver JM (1988) A visual analogue scale in the assessment of dental anxiety. *Anesth Prog* 35, 121-123.
10. Facco E, Zanette G, Favero L, Bacci C, Sivolella S, Cavallin F et al. (2011) Toward the validation of visual analogue scale for anxiety. *Anesth Prog* 58, 8-13.
11. Facco E, Stellini E, Bacci C, Manani G, Pavan C, Cavallin F

- et al. (2013) Validation of visual analogue scale for anxiety (VAS-A) in preanesthesia evaluation. *Minerva Anestesiol* 79, 1389-1395.
12. Williams VS, Morlock RJ, Feltner D (2010) Psychometric evaluation of a visual analog scale for the assessment of anxiety. *Health Qual Life Outcomes*, doi: 10.1186/1477-7525-8-57.
 13. Humphris G, Crawford JR, Hill K, Gilbert A, Freeman R (2013) UK population norms for the modified dental anxiety scale with percentile calculator: adult dental health survey 2009 results. *BMC Oral Health*, doi: 10.1186/1472-6831-13-29.
 14. Kindler CH, Harms C, Amsler F, Ihde-Scholl T, Scheidegger D (2000) The visual analog scale allows effective measurement of preoperative anxiety and detection of patients' anesthetic concerns. *Anesth Analg* 90, 706-712.
 15. Wetsch WA, Pircher I, Lederer W, Kinzl JF, Traweger C, Heinz-Erian P et al. (2009) Preoperative stress and anxiety in day-care patients and inpatients undergoing fast-track surgery. *Br J Anaesth* 103, 199-205.
 16. Tunc EP, Firat D, Onur OD, Sar V (2005) Reliability and validity of the Modified Dental Anxiety Scale (MDAS) in a Turkish population. *Community Dent Oral Epidemiol* 33, 357-362.