Beyond the Relief of Pain: Dentin Hypersensitivity and Oral Health-Related Quality of Life

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Article Info	ABSTRACT
	Pain is a constant symptom of dentin hypersensitivity (DH), which is a common condition that affects daily life and negatively affects the quality of life (QoL). Diagnosis and outcome measurements following the treatment of the disease require accurate pain assessment. The definition of pain underlies the complexity of its measurement as different factors modulate daily experience. The reproducibility of the prescribed stimuli for inducing DH pain clinically is difficult to achieve. This pain mevaasurement is made with unidimensional scales that are inadequate to capture the other dimensions of pain. The only specific QoL tool available for DH still requires testing in other populations and cultures. This article reviews the appropriateness of the current methods of DH pain assessment and the tools that consider the other pain dimensions. It also looks at its impact on the oral health-related quality of life (OHRQoL) of people with DH. The findings will create interest and facilitate research in this field of DH pain measurement and management. **Keywords:** Dentine Hypersensitivity; Pain; Outcome Assessment; Health Care; Health-Related Quality of Life; Oral Health

INTRODUCTION

Dentin hypersensitivity (DH) is a common condition that results in pain and distress. It is associated with episodes of discomfort or acute pain stimulated by activities or substances encountered every day, such as tooth brushing, drinking cold, sugary or acidic fluids, and cold air. The pain is described as short, sharp, and rapid in onset, lasting through the period of contact with the stimulus. It varies in intensity from mild discomfort to extreme severity. Others have described the pain as a dull, throbbing ache that lasts longer than the period of contact with the stimulus [1]. It may emanate from one or several teeth, with the perception of intensity related to the patient's pain tolerance as well as to emotional, physical, cultural, and social factors [2-8]. DH pain is believed to fit the criteria of some of the pain

terms recognized by the International Association for the Study of Pain (IASP) [5]. However, compared to other body parts, pain perception from oral conditions, including DH, is considerable relative to the actual cause of the pain [6]. Sufferers have described DH-associated pain as being problematic enough to affect eating, sleeping, and work [2]. Presently, there is little doubt about the high prevalence of the pain of DH among adults of different populations around the globe, with the probability of an increase with time among the elderly [7]. A significant number of patients live with the pain, which though acute in nature, is borne over a long time. Its prolonged and repetitive nature over such long periods made Gibson et al [8] suggest the consideration of DH as a chronic pain condition. Thus, its sequelae are apparent in its impact on physical, emotional, and cognitive functioning, on social and family life, and on the ability to work and secure an income [9]. Meaningful assessment of long-lasting pain is therefore a demanding task both in clinical practice and when conducting trials of management of long-lasting pain [10]. Assessing and monitoring the pain of DH is essential to its management. Seeking ways to relieve the pain has been a significant focus among clinicians and researchers as shown by the numerous treatment regimens available for in-office and home management of the condition. As suggested by Holland et al [11], to aid the management of those affected, the emphasis has been on the diagnosis and quantification of this pain mainly by evaluating either the pain threshold, as the stimulus is varied in intensity, or the individual's subjective response to a constant stimulus. In the latter, the individual's response varies, and the pain intensity is assessed with numerical rating scales (NRS), verbal response scales (VRS), and visual analog scales (VAS) [11,12]. The degree of pain reduction, as rated by the scales, has been used as outcome measures for different treatment methods [12,13]. These methods of assessment for inducing DH pain, as well as for measuring its presence and intensity, are not without their shortcomings. It is known that

the presence and severity may differ for different stimuli [12,14], and patients have reported a wide variety of pain-producing stimuli [15-17]. However, not all of these stimuli are suited for quantifying DH in clinical practice [14-18]. Thus, the stimuli used for clinical evaluation and outcome measures are those that are physiological and easily controllable [19]. Though adequate for clinical practice and trials, these stimuli appear limited and may not reflect the actual triggers that individuals encounter in daily life. Ide et al [20] also indicated the difficult reproducibility of these evaluation methods, even with the use of standardized techniques. Furthermore, the pain scales used for evaluating pain intensity are all unidimensional. Therefore, clinical success, as measured by these indices, may not be perceived as a success by the patient. An individualized pain management plan is essential to pain management, which requires tools with reliable and accurate assessment methods to provide an effective, all-inclusive patient experience [21]. A biopsychosocial model that recognizes the physiological, psychological, and environmental factors that influence the individual's pain experience incorporates this plan; the currently used unidimensional scales cannot assess these components [21].

As defined by the World Health Organization (WHO), a complete assessment of the effect of any disease on health should include its impact on the functional, social, and psychological well-being of those affected [22], which will require a patient-based assessment of health status in addition to clinical parameters for completeness. This definition emphasizes the quality of life (QoL) concept as an integral part of the assessment of health status. In the absence of this assessment, there is the possibility of under-treatment of DH pain and its impact on daily activities. There have been marked differences often noted between patients' perception of their health-related QoL (HRQoL) and clinicians' assessments based on clinical parameters [23]. Such findings stress the need for the inclusion of patient-based evaluation of

health status in health measurement. The literature on DH is full of epidemiological and comparative studies on treatment agents using different pain rating scales. Nonetheless, these studies are limited in information on the assessment of the sufferer's perception of the impact of the pain on their QoL. The purpose of this paper was to review the available literature on DH pain assessment and its impact on everyday life, DH and oral HRQoL (OHRQoL) measurement, the use of patient's perception of the condition's impact, and the effect of treatment on outcome measures as a complement to clinical assessment methods.

Clinical Assessment of DH:

The mainstay of clinical diagnosis of DH is the assessment of its pain and elimination of possible differentials. It is necessary to obtain a comprehensive history of diet, oral hygiene practices, behavior patterns, and previous dental therapies in the confirmed case of DH to identify risk factors that may be modified during management. Following the elimination of differentials, stimulation and assessment of the pain are fundamental as the longitudinal monitoring of the pain is necessary to assess the effectiveness of treatment methods.

Stimulation of DH Pain:

The external stimuli eliciting dentinal pain can be thermal, osmotic, chemical, physical or mechanical. The thermal stimuli include hot and cold foods and drinks as well as warm or cold blasts of air entering the oral cavity. Osmotic stimuli include sweet foods and drinks. Acidic stimuli include citruses, acidic beverages, and medicines. Common mechanical stimuli are toothbrushes, cutleries, and dental instruments [3]. Commonly used diagnostic tools comprise blasting air using an air-water syringe and scratching the tooth surface with a sharp dental explorer [15-18]. These evaporative and tactile stimuli are believed to be able to provoke the DH-associated pain [12,18]. This assumption, however, has not considered the specific stimulants perceived by the patients in their daily life. Other known stimuli, such as hypertonic solutions, cold water, and electrical stimulation, have been discouraged due to the difficulty in controlling the response and the possibility of false-positive results [24]. Various authors support the tactile method for its simplicity [12,15,18], and though previous works have indicated good validity for this technique [20], it has been criticized because variability in the pressure applied [4] causes susceptibility to reproducibility problems [20] during the longitudinal assessment of the outcomes. Thus, due to the varied pressure, patients may still have DH pain from mechanical stimuli in their daily life, even with a negative response to a tactile stimulus in the clinic. Cold air current stimulus is acknowledged to be a more duplicable method of DH pain stimulation, and it is generally accepted that the stimulus should be supplemented by a tactile stimulus to enhance the measurement sensitivity [19], with the least severe stimulus always applied first to avoid a negative impact on the results [18]. Also, a sufficient time interval, though still unknown and likely to be different for the different types of stimuli [12], between stimuli applications should be allowed to prevent interactions between two stimuli. However, these recommendations have not addressed the possibility of variability in an individual's pain responses to these stimuli over time. Considering these, the reproducibility of these DH-pain stimulation methods in clinical trials has been called into question as the results are believed to be less than expected [20].

Pain Assessment in DH:

Pain is described as a subjective and multidimensional experience. Variables including personality, psychology, degree of fear or anxiety, culture, and society affect its perception [4]. Dental practitioners need to assess and monitor the pain of DH as they are confronted regarding the severity of symptoms or the effectiveness of therapeutic interventions [12]. The patient's subjective response to the presenting stimulus has been the primary way to evaluate DH pain. The ability to quantify this pain resulting from the stimulation of exposed dentin would be useful

in the assessment of the severity of the condition and evaluating the effect of different treatment strategies [12].

Holland et al [11] suggested recommendations for DH evaluation using either a stimulus-based assessment or a response-based assessment. Stimulus-based methods involve pain threshold measurement while response-based methods involve pain severity estimation. The subject's response is held constant at the pain threshold in the stimulus-based assessment but the stimulus is varied in intensity. The Yeaple probe exemplifies this method to obtain the patient's pain threshold for the hypersensitive tooth when the intensity of the stimulus (pressure) varies [4]. This method, however, has some drawbacks; repeated stimulation may cause a sensitivity change. Also, the increasing stimulus from the probe may result in the patient anticipating the pain, thereby influencing the outcome. For the response-based method, the stimulus is held constant while the response from the patient varies and is measured. Although patients have reported a wide variety of pain-producing conditions and a great combination of stimuli [15-18], the most commonly used tools for DH-pain induction for this method are blasting air using an air-water syringe and scratching the tooth surface with a sharp dental explorer [15,18]. Different pain scores have been used to assess the pain following any of the stimuli mentioned above or a combination of the responses from both stimuli, which may enhance sensitivity measurement [12,20]. The degree of pain reduction calculated by the pain scores serves as an outcome measure of different treatment methods [12].

Pain Rating Scales in DH:

The response-based method, the more physiological of the two methods, utilizes NRSs and VRSs to assess the severity of pain induced by the applied stimulus. The most commonly used scales for studies on DH are the Schiff cold air sensitivity scale (SCASS), the VAS, the VRS, and the NRS. The SCASS is a four-point scale mainly used to assess subjects' responses to air blast. It is a simple and reproducible DH-measurement technique [20,25] but has a limited number of categories, which lowers its sensitivity [26]. The clinician rates the response as follows: 0=no response, 1=response+subject does not request stimulus discontinuation, 2=response+subject requests stimulus discontinuation, and 3=pain+subject requests stimulus discontinuation [26].

Another tool, the VAS, consists of a 10-cm horizontal line bordered by verbal descriptors of pain intensity. The descriptor "no pain" is to the left of the line while a phrase describing an upper pain intensity limit such as "worst pain possible" or "extreme pain" is at its right end. The patient is asked to draw a line perpendicular to the VAS at their perceived pain-intensity level. After that, the score is measured from the zero mark to the patient's indicated mark [27,28]. Similar to the VAS, the NRS is an 11-point scale consisting of a range of numbers, usually 0-10, although other ranges have been used [29,30]. Patients are told that zero represents "no pain", and ten represents a maximum pain level usually described as "worst pain possible" or another similar description [31]. Patients indicate pain intensity by picking a number from 0-10 that best represents their pain level [29,32]. The VRS, similar to the SCASS, consists of a series of adjectives that reflect the degrees of pain severity. The severity levels have a grading from "no pain" to any word or phrase used to designate extreme pain [29]. It may have four or more degrees depending on the version. Patients select the adjective that best describes their pain intensity following pain stimulation by any of the response-based stimuli.

Both NRS and VAS are equally sensitive in assessing acute pain and are superior to the four-point VRS and SCASS. The VAS detects a small change in pain; however, the small number of categories in the VRS requires a much more significant change in pain for detection on the scale [33]. Other studies also have demonstrated the power of the NRS and the VAS to detect a difference in pain intensity over the VRS [33,34]. The test-retest reliability of the VAS has been proven for acute pain

when administered repeatedly within a short period of time [28]. Lara-Muñoz et al [35] established the validity of the VRS in a study that tested the VAS, the VRS, and the NRS in experimental conditions. The three scales were found to be reliable and valid. The authors concluded that the VRS delivered reliable information [35]. However, a complication in studies of test-retest reliability may be temporal changes in what is being measured (DH), especially in efficacy studies of DH that involve placebo treatment as this assumes that DH pain has remained constant over the study period. The problem with such an approach is that the difference in the statistical mean values of measured pain only reveals the average change in the study population and neglects individual subject variations [20]. These variations in sensitivity may have influenced the outcomes and may contribute to reductions in measured reproducibility.

Due to similarities between the scales, Bijur et al [32] found a significant correlation between the VAS and the NRS with a strong level of agreement between both tools. Correlation between the VRS and the VAS has also been demonstrated in groups of patients [20,36] but is reduced when patients' results are examined individually [20]. The mild, moderate, and severe pain categories may agree to different values on the VAS for one patient at different time points [34]. The correlation coefficients vary widely and change throughout the VAS range. This implies that although there might be a good correlation between the VRS and VAS scores at the lower end of the scale, the association between the two declines as the patient's pain increases [33].

Of these scales, the VAS is the most commonly used in clinical trials of DH. Though useful, it is unidimensional and does not distinguish between the sensory and affective components of pain. In spite of this obvious shortcoming, the degree of pain reduction, as measured by the pain scales, remains the basis of outcome measures following DH treatment. This assessment leaves out the affective components of pain and the coping mechanisms that the patients have adopted. The assessment methodology for DH pain should allow for more reliable measures that consider the different dimensions of this pain. There may thus be a role for chronic pain scales in the assessment of this condition. As suggested, DH should be considered as a chronic pain condition given its recurring nature and the length of time that those affected have lived with it [8]. With the functional, psychological, and social impairments reported with the condition, the tools developed for the assessment of chronic pain may be better able to assess DH pain and its impact. Such generic chronic pain assessment tools, including the Brief Pain Inventory (BPI), the McGill Pain Questionnaire (MPQ), and its short form (SF-MPQ), assess the intensity and the impact of the pain. The BPI assesses pain intensity and the disabilities associated with it [37], and the MPQ assesses the sensory, affective, and evaluative dimensions of the pain [38].

Oral Health and QoL:
"Oral health has been defined as the level of health of the oral tissues that contribute to overall physical, mental, and social well-being by enabling individuals to eat, communicate, and socialize without discomfort or embarrassment and which allows them to continue in their chosen social roles" [39]. This definition represents a multidimensional concept beyond the signs documented by clinical indices. Representations of oral health have moved from tooth mortality to overall well-being and from single-dimensional concepts to multidimensional ones [40-42] that will require multidimensional tools for assessment.

The relationship between health and QoL was first inferred in the WHO's definition of health as a "state of complete physical, mental, and social well-being, not merely the absence of disease or infirmity" [22]. This definition included QoL as an essential domain within the broader definition of health, thus opening up the discourse on the patient's perspective of the effect of his/her health states on daily life. It expanded the concept of health and

signaled a transition from the long-held belief that health is the absence of pathology [43] to that which includes the functional and psychosocial impacts of disease on the sufferer [44]. These impacts represent the patients' perception of the effect of the disease and its treatment on their daily life. Clinicians and researchers agree that the patient's perspective is as important as clinical outcomes when evaluating the success of treatment. Therefore, patient-reported outcomes (PROs), and in particular, the concept of HRQoL and OHRQoL have gained popularity [41,45]. HRQoL is a dynamic, subjective concept, encompassing health status and satisfaction with a broader range of domains like environment, economic resources, relationships, and other factors perceived as critical to everyday living [40]. OHRQoL has been defined as a compound construct reflecting on people's comfort, eating, sleeping, social interaction, self-esteem, and satisfaction concerning oral health and its impact in everyday life [40,42]. Similar to the pain rating scales, OHRQoL can be used to assess significant changes in oral health over time. However, unlike the pain rating scales, the OHRQoL measurement tools are multidimensional and can evaluate other aspects of pain and its impact.

OHRQoL Tools and DH:
So far, the discussion suggests that the tools available for DH assessment do not capture the condition's impact on the QoL of those affected; the importance of assessing QoL in patients living with pain has been documented [46]. Three categories of OHRQoL measures have been identified: social indicators, global self-rating, and multiple items questionnaires [40]. Multiple items questionnaires are the most widely used method to assess OHRQoL. These measures can be classified into generic instruments that measure oral health overall versus specific instruments. Several of these instruments have been constructed and validated to assess OHRQoL with increasing demand for more specific tools. Presently, both generic and disease-specific measures of health status are employed. Researchers have

used a few of these in the assessment of DH. The Oral Health Impact Profile (OHIP) and the Dentin Hypersensitivity Experience Questionnaire (DHEQ) are popular tools in this respect.

The OHIP:
Developed by Slade and Spencer in 1994 [47], the significant advantage of the OHIP is its basis on the Locker's conceptual framework and input from patients (not dentists) with a variety of oral conditions [42,48]. This increases the possibility of "tapping into" the dimensions of oral disorders that are important to the patients [49,50]. The questionnaire attempts to measure the effects of the frequency and severity of oral complications on functional and psychosocial health. It consists of 49 statements rephrased as questions and divided into seven theoretical domains of functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap. Responses are rated with a Likert scale and are coded 0, 1, 2, 3, and 4 for a data entry [48]. For clinical application, Slade [49] developed a shorter version with only 14 questions, the OHIP-14, with two items in each of the seven domains. The questions in this version retain the original concept of the OHIP-49 version [49]. Overall and individual subscale scores may be calculated for either of the versions used. Higher total OHIP scores indicate poorer OHRQoL.

The DHEQ:
Boiko et al [45], in 2010, developed and validated this DH-specific measure of QoL. The DHEQ is a 48-item questionnaire. Thirty-four items are impact subscales divided into five domains of functional restrictions, coping, social impact, emotional impact, and identity measured on a 7-point Likert scale. Nine items are for introductory descriptors of pain and three pain scales (VAS). Four items are related to the overall effect of DH on QoL, and one item corresponds to the global oral health rating. The total score for the impact scale is the sum of the item scores, and this can be applied to

the subscale scores as well. The extent of the impact is calculated as the number of the impacts to which each subject mostly agrees ("strongly agree", "agree", and "agree a little"). The higher the total score of the DHEQ, the more impaired the patient's OHRQoL. To facilitate clinical usage, Machuca et al [51] derived and validated the short forms: the DHEQ-10 and the DHEQ-15. The DHEQ-15 is more favored as the items are determined by the patients' most frequently experienced items and those most important to them. Also, more items in the DHEQ-15 gives it higher reliability compared to the 10-item version [51].

Assessment of OHRQoL in Patients with DH:

DH assessment of pain experience using PROs in clinical trials is limited but gaining acceptance among researchers. Few studies, however, have assessed PROs in people with DH. The OHIP, unlike the DHEQ, has been validated in several languages and has had more applications, though few, to patients with DH. The OHIP-49 and OHIP-14 have been used in patients with DH for cross-sectional and longitudinal assessments. Bekes et al [52] used the German version of the OHIP-49 to assess OHRQoL among patients seeking care for DH compared to the general population and showed better QoL in the general population. Longitudinal studies have also revealed improvement in the QoL of patients following DH treatment [53-55]. Following the proposal of the DHEQ by Boiko et al [45], cross-sectional and longitudinal studies have been done to validate and test the properties of the 48-item DHEQ in English [56], Chinese [57], and Turkish [58] languages. They all showed it to be a valid tool for distinguishing patients with varying degrees of DH, highly responsive to changes in the experiences of individuals with DH. The scores significantly correlate with the patients' self-global oral health rating, indicating good convergent validity [56-58]. Although the short version of this tool has been validated in English and verified to have cross-cultural validity in Brazilian-Portuguese [59] and Chinese [60,61]

languages, its use in clinical trials of DH is limited. Future studies will need to examine this tool translated into more languages for external validity and consistency.

The OHIP has been useful in the exploration of the relationship between QoL and oral health status in different countries. This makes it the most widely used tool for the assessment of OHRQoL. Thus, it has the advantage of extensive usage with room for ample testing for validity and reliability. However, the developers of the DHEQ believe that since generic instruments, such as the OHIP, are useful for various oral health disorders, they enquire about a broad spectrum of limitations and dysfunctions. This would be a disadvantage as the OHIP may not detect the impact of DH and may not differentiate it from other impacts [45]. The study by Bekes et al [52] revealed that the OHIP fails to distinguish the impact of DH in patients seeking treatment from those of other conditions among the general population. The OHIP, as a generic tool, may be more appropriate when comparisons between different oral disorders are required.

The DHEQ also covers a broader range of impacts explicitly associated with sensitive teeth, including coping strategies employed by the patients, which is also a way of impact measurement by assessing deviations from normal life caused by DH. This may provide better sensitivity to the variables appraised in DH patients. The inclusion of global rating into the DHEQ is another added advantage as it considers the patients' overall perception of their oral health, which could be correlated with the sum of the other items to assess agreement between the two measures, multiple items, and global rating. The DHEQ, therefore, provides an alternative to the generic OHIP because of its direct reference to the problems associated with DH [45,56].

CONCLUSION

The pain associated with DH is important to the patients as it affects their QoL. Therefore, its measurement goes beyond the clinical pain stimulation and intensity assessment with unidimensional pain scales. An assessment

that considers the adverse impact on QoL will be difficult to achieve using the present clinical indicators. It is also likely that the contribution of measurement variability may reduce the ability to demonstrate clinically important treatment outcomes necessary for establishing a patient-centered outcome measure. Incorporating PROs and specific QoL measures can compensate for the limitations in pain stimulation and assessment and can thus allow the selection of treatments that the patients value. These OHRQoL measures are not proposed as alternatives to the established clinical indicators but rather complementary to provide a more complete assessment by considering the other dimensions of DH pain. The available DH-specific QoL tool still requires further validation in different cultures and languages as well as comparative studies, where two or more measures are compared, to provide opportunities for testing and refinements to suit different populations.

CONFLICT OF INTEREST STATEMENT
None declared.

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