Face Scales and Facial Expression Analysis to Assess Clinical Pain Intensity

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Abstract : Healthcare providers are hard to know patients' pain intensity directly because of subjective experience of patients themselves. While patients are usually apt to hesitate to express their pain just as they feel in front of health professionals because of their reserve or fear to diagnose severe disease. For that, healthcare providers may underestimate patients' pain intensity. This paper aims to discuss how much grasp and assess patients' clinical pain for healthcare providers, from the viewpoint of Face Scales and Facial Expression Analysis. Face Scales are available for patients themselves to express their pain intensity towards healthcare providers, even if it is not easy to convey verbally. Facial Expression Analysis is applicable for health professionals in clinical situations as to subtle facial expressions, avoiding misinterpretation and overlooking through the training of Facial Action Coding System (FACS) developed by Ekman and Friesen (1978). Applying both merits of Face Scales and Facial Expression Analysis would be helpful to understand patients, pain intensity.

Key words : pain intensity, Face Scales, Facial Expression Analysis, FACS

1. Introduction

Pain, one of the defense reactions of a human body, is important to diagnose one's disease and to prognose one's treatments. Various sorts of pain in dentistry are such as pulpitis, gingivitis, tooth mobilization, hypersensitivity, and food impaction. Besides them, there is a transient pain after setting of prosthetic appliance.

Since pain is a subjective experience known only to patients themselves, it is difficult for healthcare providers to grasp its intensity of patients directly. In many cases, healthcare providers know it from medical interview. Each individual has various range of pain threshold. Even if health providers judge that their patients' pain intensity is not so severe, while the patient may be intolerable pain[1]. Pain intensity is identified as significant predictors for pain medication[2] . Moreover, patients usually

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tend to hesitate to express themselves just as they feel in front of health professionals because of their reserve or fear to diagnose severe disease. For that, healthcare providers tend to mistake to interpret patients' pain intensity. That is, there are two opposite points from each side: patients should encode their expressions of emotional messages as they feel ; and health professionals should decode their patients' messages they have expressed.

This paper will discuss from the viewpoint of Face Scales and Facial Expression Analysis how much health professionals grasp and assess patients' clinical pain.

2. Face Scales and clinical assessment for patients' pain

Face Scales (FS) are a spectrum of facial expressions assigned to numeric values to represent their rank order within a series from the least distressful to the most distressful. Mainly they have been separately developed for pediatric patients to assess pain intensity, to show such as anxiety, distress, or QOL.

For the applied medical researches after 1980s (Table 1), Face Scales were used with hand-drawn illustrations for those who are unable to fill out in questionnaires because of language difficulties or pain of rheumatoid arthritis[3,4] . From 1984, in mainly Pediatrics, Face Scales have been used to assess anxiety and pain intensity level[5-28]. Clinical pain intensity is a significant problem for the elderly. Herr KA., et al. (1998) evaluated and demonstrated the validity and reliability of the Faces Pain Scale developed by Bieri et al., using them for the elderly aged from 65 and older[29]. Especially, it has been applied to the fields for elderly adults who are cognitively impaired or unaccustomed to answer the questionnaires[29-31].

While in dental researches, Williams JMG., et al. (1985) assessed anxiety of children (mean age 11.5 years) before dental treatments with a Picture Analogue Scale, face version of Visual Analogue Scale (VAS). It comprises 7 drawings of a face graded from distressed to happy[32] . If it is difficult to grade with Visual Analogue Scale which is widely used to assess pain, one can easily answer some questions with FS. Buchanan H., et al. (2002) developed Facial Image Scale (FIS) for young children to assess the state of dental anxiety. It is consisted of 5 faces ranging from very happy to very unhappy, which makes young children easier to recognize and easier to score in a clinical situation[17] . FIS was also a suitable measure for young children as well as their parents and dentists[18] . It is possible to assess them objectively even if it is practiced by the infants, their parents, and healthcare providers. The data given by both patients and healthcare providers can be compared with each other. Moreover, Buchanan H. (2005) developed a Smiley Faces Program (SFP), an interactive computerized version of the Facial Image Scale for dental anxiety[19] .

For others, in dental researches regarding pain intensity the following cases were reported: temporomandibular disorder pain (1988); pain and its side effects as a result of orthodontic therapy with fixed appliances (1999); pain and discomfort after periodontal scaling and root planing (1999)[33-35] . From the research of Ando et al. (2003), modified face scale of Lorish CD., et al. (1986) was used to assess QOL of 70 and 80-year-old elderly from the viewpoint of masticatory function, and it showed its correlation[36] . Then, Face Scales are used widely for post-operative pain of dental surgery as to impacted mandibular third molars (2004); initial

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Table 1 Face scales on medical and dental research papers (1982-2007)

First aurhor (year)	Scale	Age range	Mesuring Purposes	Measureing Context
Frank AJM, et al. (1982)	Analogue Pain Scale; 2 Face Scales drawn by JMHM	53-83 years	shoulder pain	rehabilitation for left and right hemispheric stroke patients
LeBaron S, et al. (1984)	Face Scale (LeBaron S, et al)	6-18 years	dental anxiety	dental treatment
Williams JMG, et al. (1985)	Picture Analogue Scale	8-14 years	mood	Prosthetic treatment
Lorish CD, et al. (1986)	Face Scale (20 faces)	average age 54years	chronic pain	local citizen centers, a general hospital, and an oriental medical hospital
Maunuksela E-L, et al. (1987)	Pain-Rating Scale (Maunuksela, et al.)	1.6-17.6 years	pain of inhaling behavior	treatment of acute respiratory diseases
Wong DL, Baker CM (1988)	Faces Rating Scale (Wong and Baker)	3-18 years	rheumatoid arthritis pain	hospital
Kuttner L, et al. (1989)	Children's Anxiety and Pain Scales (CAPS: Kuttner, et al.)	4-10 years	postoperative pain	Surgical Day Care Unit
Bieri D, et al. (1990)	Faces Pain Scale (Bieri, et al)	average age 6.8 and8.7 years	anxiety	dental treatment
Douthit JL, et al. (1990)	Faces Rating Scale (Douthit)	3-7years	hernia repair of pain	medical center
Goddard JM, et al. (1996)	Sheffield Children's Hospital pain assessment tool based on the face scale of Brown TCK et al., 1992)	2 years	pain intensity	school
Goodenough B, et al. (1997)	Faces Pain Scale (Bieri et al., 1990)	4-6 years	postoperative pain	hospital
Ohke H, et al. (1997)	Face Anxiety Scale (Kudo M, et al. 1995)	22-33 years and 23-34 years	anxiety	hospital (ICU)
Herr KA, et al. (1998)	Faces Pain Scale (Bieri et al., 1990)	over 65 years	anxiety	dental treatment
Terai T, et al. (1998)	Modified Face Scale (Lorish CD et al., 1986)	61.9±8.5 years	pain	hospital
Chambers CT, et al. (1998)	Original Faces Pain Scale	5-12 years	QOL	mastication
Goodenough B, et al. (1999)	Faces Pain Scale (Bieri et al., 1990); Facial Affective Scale (McGrath PA et al., 1985,	4-10 years	anxiety	dental treatment
Chambers CT, et al. (1999)	5 face scales(Bieri et al., 1990; Wong and Baker, 1997; Maunuksela et al., 1987; LeBaron and Zeltzer, 1984; Kuttner and LePage, 1989)	5-12 years and 25-56 years	anxiety	dental treatment
Buchanan H, et al. (2002)	Facial Image Scale	3-18 years	needle pain	hospital (blood sampling)
Bulloch B, et al. (2002)	Faces Pain Scale (Bieri Det al., 1990)	5-16 years	needle pain	hospital (blood sampling)
Buchanan H, et al. (2003)	Facial Image Scale	3-18 years	reliability and validity of faces pain scale	local citizen centers, church groups and senior retirement centers
Bosenberg A, et al. (2003)	Six-graged Faces Scale	4-12 years	postoperative pain	care unit (ICU)
Ando Y. et al. (2003)	Modified Face Scale Lorish CD et al., 1986)	70 and 80 years	needle pain	child care centres
Miro J, et al. (2004)	Catalan version of Faces Pain Scale (Hicks et al 2001); Facial Affective Scale (McGrath et al. 1996)	7-15 years	anxiety	dental treatment (effects of a local anesthetic tape)
Perrott DA, et al. (2004)	Faces Pain Scale (Bieri et al., 1990); Facial Affective Scale (McGrath et al., 1985)	5-9 and 10-15 years	peri-operative pain	hospital
Chambers CT, et al. (2005)	5 Faces Scales (Bieri et al., 1990; Wong and Baker,1988; Maunuksela, 1987; LeBaron and Zeltzer, 1984; Kuttner and LePage, 1989)	5-13 years	anxiety	dental treatment
Buchanan H. (2005)	Smiley Faces Program	6-15 years	arthritis pain	pain relief by medication
Kim EJ, et al. (2006)	11 face modified version of McGrath Faces Pain Scale (1987)	over 65 years	reliability and validity of faces pain scale	school
Metivier H, et al. (2006)	Faces Pain Scale (Wong and Baker, 1988)	4 years	anxiety and pain	pediatric
Benaim C, et al. (2007)	Modified Faces Pain Scale (Bieri et al., 1990)	18-80 years	anxiety and acute pain	children's cancer treatment and research center
Howard KE, et al. (2007)	faces version of Modified Child Dental Anxiety Scale	8-12 years	preoperative pain	children's hospital
Kamashita Y, et al. (2007)	original Faces Scale; modified faces scale (Lorish CD et al., 1986);	52-81 years	painful events	hospital

injection pressure for local dental anesthesia (2005); and to assess patients' mood for the use of denture [37-39]. After the middle of 1980s, type of Face Scales have been diversified, and reliability and validity of Face Scales have been examined in view of the number of faces and the methods of face illustration such as hand-drawn pictures, computerized images, or photographs[8,27].

3. Applied Facial Expression Analysis to assess clinical pain intensity

Facial Expression Analysis is a study to understand the mechanism of expressing one's feeling in facial displays (encoding), and interpreting the meaning of its message (decoding). From the first systematic research of facial expressions studied by Charles Darwin (1872), many researches have been practiced[40]. What is important for the system describing facial expressions objectively is to analyze the specific facial expression. Facial Action Coding System (FACS) developed by Ekman and Friesen (1978) is one of the approaches anatomically based on the system for measuring all facial movements of a single facial muscle or a group of muscles which move as a unit[40-43]. The basic elements of FACS relie on 44 Action Units (AUs). It also allows for coding of the intensity of each facial action reliably graded on a 5-point scale for intensity.

Researches applying FACS have demonstrated that useful information of pain can be obtained through the observation of facial expressions[44-45]. Observers can also distinguish facial expressions of pain from the ones of other emotions[45]. Important message from facial expressions tends to be overlooked, since most of all, facial expressions with emotion appear in very short time, a few seconds. Especially, sub-tle facial expressions showing real intention appear and disappear immediately in 1/5 of a second or less. Motion of muscles surrounding eyes, particularly eyebrows, shows key points to know this subtle feeling[41,46]. The application of FACS is useful to become more sensitive for subtle facial expressions and to avoid missing small motion or misinterpreting as signals other than pain[44].

In medical researches, Prkachin KM., et al. intensely examined to decode patients' pain, using 4 facial movements associated with pain based on FACS: brow lowering, tightening of the orbital muscles, nose-wrinkling or lip raising, and eyelid closure[44,47]. The 30 min. of training would be required to learn 4 facial movements of FACS. The ratings of untrained observers significantly underestimate patients' self-reports by 50-80%[44]. The research indicates that FACS training is more effective to read subtle facial expressions induced by low levels of pain, and more sensitive to variations in facial expressions which still signal a state of emotions other than pain, in order to avoid misinterpretation or overlooking.

Gilbert CA., et al. (1999) developed Child Facial Coding System (CFCS), combined system with the elements both Neonatal Facial Coding System (NFCS) of Grunau RVE (1987) and Facial Action Coding System (FACS) of Ekman and Friesen (1978). It is a system coded for the 13 facial pain actions such as to open lips, to lower brows, etc, to assess post-operative pain in infants aged 13-74 months. It is reported that within an hour after a minor surgery, children aged 1-6 consistently display the following facial action pattern: brow lowering, deepened nasolabial furrow, cheek raising, open mouth horizontally and vertically[48].

In dentistry, LeResche L., et al. (1992) ana-

lyzed chronic pain over of temporomandibular disorder over 6 months continuously, using FACS. Facial pain expressions became more frequent in chronic cases compared with recent onset cases[49]. Patients with chronic pain may tend to face with more daily stress because of anxiety for the period of treatment, distress to pain, mastication disorder, trismus, and so on. These factors would be related with encoding facial expression of chronic pain. Moreover, Hsu K-T., et al. (2007) applied FACS, limited to 6 Action Units as to pain, to evaluate orofacial pain in cognitively impaired older adults aged over 65. This study suggests that the facial expressions which are significantly correlated with orofacial pain, is upper-face expressions: brow lowering, lid tightening, and cheek raising[50].

4. Limitations of using Face Scales and Facial Expression Analysis as a Clinical Research

Face scales beginning with "no pain" smiling faces show significantly higher pain intensity rating than those with "no pain" neutral faces[13,51]. Some patients recognize that the faces of the Facial Pain Scales represent sadness rather than pain. Therefore, researchers recommend for clinicians to select at least two different scales to use in daily practice, for instance, Faces Pain Scale and Visual Analogue Scale[52].

On the other hand, though FACS can exactly assess the change of facial expressions, at least 100 hours will be required for health care providers to master FACS with 44 action units (AUs). Also enormous time consuming is required for analyzing the facial expression by slow motion of video recording. These problems tend to encourage the use of small subjects and behavior samples; to prolong study completion

times; to limit the generalizability of the findings of the studies. They are liable to be impractical in the clinical practice[44,53]. Therefore, Cohn JF., et al. (1999) developed automated method of facial display analysis based on manual FACS coding. Average agreement with manual FACS coding is 92% or higher for the action units around the brow, eyes, and mouth[53]. In clinical settings, Prkachin KM., et al. applied to FACS with 4 limited facial actions with clinical and experimental pain: brow lowering, tightening of the orbital muscles, nose-wrinkling / lip raising and eyelid closure[44,47,54].

The elderly people tend to be weak with encoding of facial expressions. Facial structural change such as wrinkling makes hard to decode facial expressions compared of those of the youth. Various emotions will be appeared on the face, that is, not alone. Complex emotions such as anxiety, surprise, sadness, or anger will be mixed on the face and immediately disappear. Even if it is the same emotion, expression will be different according to their grade and one's experience. Some will hide it with smiling though they really feel severe pain[46].

5. Conclusion

To know patients' pain intensity from their facial expressions is taken in daily practice as supplementary elements for patients' verbal description. Although Visual Analogue Scale is widely used to assess clinical pain, Face Scales make especially young children and elderly people easier to score their delicate pain intensity which is hard to convey verbally. On the other hand, subtle facial expressions appear and disappear immediately. Facial Expression Analysis is applicable for health professionals to become more sensitive for a moment change of facial expressions through FACS training. It would be

effective to notice patients' pain intensity from a moment change of subtle facial expressions under treatment or in the case of patients' persevering. Facial Expression Analysis has been applied from infants to elderly people on the researched reports. Applying both merits of Face Scales and Facial Expression Analysis would be helpful to understand patients' pain intensity.

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