The use of a visual analogue scale in observer assessment of postoperative swelling subsequent to third-molar surgery

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Postoperative swelling after mandibular third-molar surgery was evaluated in 40 patients. Three-dimensional metric measurement of swelling was compared with observer assessment of swelling from clinical examination, from pairs of en-face photographs, and from patient self-assessment, all using a 50-mm visual analogue scale (VAS) for registration. The photographs were evaluated by two groups of observers: general practitioners ($n = 5$) and oral surgeons ($n = 5$). The following conclusions were drawn: observer assessment of swelling from clinical examination and from judgement of photographs underestimates large swelling and slightly overestimates small or no swelling compared with objectively measured swelling. General practitioners and oral surgeons assess swelling from photographs almost identically, with a slight tendency for more underestimation of large swelling by the younger oral surgeons. A 50-mm VAS seems sufficiently reliable for assessment of swelling. □ *Edema; photography, clinical; photography, evaluations; surgery, oral*

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Determination of swelling after third-molar surgery has been widely used as an important indicator of the postoperative inflammatory reaction. For the quantitative evaluation of swelling, several methods have been applied, both subjective and objective, with various degrees of documented accuracy.

Subjective single- or multiple-observer clinical assessments with registration on verbal or non-verbal rating scales with two (1) or more grades (2, 3) were frequently used until the development of various methods of objective registration of swelling. Løkken et al. (3) found single-observer clinical assessment using a four-graded verbal rating scale neither accurate nor reliable compared with three-dimensional mechanical measurement of extraoral swelling.

Mechanical methods for measuring swelling after third-molar surgery include the use of calipers (4) and face bows (5, 6) (one-dimensional techniques). Changes in linear measurement between anatomic landmarks measured directly on the patient have been used to indicate the degree of postoperative swelling (7, 8) (two-dimensional techniques), and modified face bows (3, 9) and a cephalostat (10) (three-dimensional techniques) have been developed for this purpose.

Measurements of alteration of the lateral soft-tissue profile have been made on frontal radiographs with a barium-containing suspension painted on the skin (11) and on tracings from en-face photographs (12–14) (two-dimensional techniques). For some of these methods the level of reproducibility is documented (10, 14, 15).

Stereophotographic methods, as developed by Björn et al. (16) and refined by Pedersen & Mærsk-Møller (15), are probably the most sophisticated method described. However, as the methods become complex and refined, their usefulness in clinical investigations decreases, and, accordingly, the stereophotographic method seems to have been applied in very few clinical studies so far (17).

The continuously variable scales, such as the visual analogue scale (VAS), are increas-

ingly being used in the evaluation of pain (18) and may represent a more sensitive instrument for assessing pain than the conventional verbal rating scale (VRS) (19). The VAS has also been used for patient self-assessment of postoperative swelling (20, 21), and it has been stated that this method may provide a more complete assessment of postoperative swelling than does measurement of extraoral swelling alone (21).

The aim of the present study was to evaluate the use of VAS in observer assessment of swelling from clinical investigation and from pairs of en-face photographs, compared with an established (22) three-dimensional mechanical measuring system. Furthermore, an evaluation of possible differences between general dental practitioners and oral surgeons in their assessment of swelling from photographs was attempted.

Materials and methods

Forty consecutive, healthy patients, 21 females and 19 males, had 1 lower third impacted molar removed by means of a standard surgical procedure. The average age of the patients was 23.4 years, with a range of 17 to 46 years.

Within 1 h preoperatively the following base-line registrations were made:

1) Mechanical three-dimensional registration of the lateral soft-tissue profile in the area of expected swelling was done with a modified cephalostat in accordance with Tollefsen (10).

2) En-face photographs were taken by means of a standardized technique. The patient was seated on a chair without back support and asked to look directly into a vertically positioned mirror, which immediately was replaced with the camera lens (Leica M2, f = 65 mm), positioned at the level of the pupils. Lighting conditions were standardized, and the patient was asked to keep the teeth in a relaxed position 1 mm apart and with the lips lightly closed.

At 24 h postoperatively these registrations were repeated in an identical manner. The sum of differences between the pre- and post-operative metric registrations of lateral soft-tissue profile was recorded as the objectively measured swelling, later referred to as measured swelling. In addition, a clinical assessment of the swelling was performed by inspection, by an oral surgeon, using a vertical 50-mm VAS for registration. The patients were asked to assess their own subjective feeling of swelling, again using a 50-mm vertical VAS for registration.

Fig. 1. Pre- and postoperative en-face photographs of a patient with moderate swelling subsequent to surgical removal of the lower left third molar.

Black and white prints (13 × 18 cm) were made from the pre- and post-operative negatives, and special care was taken to obtain an exactly equal rate of enlargement. Pairs of photographs for each patient were mounted side by side on separate sheets (Fig. 1).

Two groups of observers consisting of five general dental practitioners (GP) with a mean age 44 years and five oral surgeons (OS) with a mean age 50 years were asked to assess individually the degree of post-operative swelling without the use of rulers or other tools. A 50-mm vertical VAS was used for recording the assessments.

All visual analogue scales for registration of swelling were arranged as vertical lines 50 mm long limited by a short horizontal line at both ends. The upper limitation was marked 'maximal swelling, cannot be worse', and the lower limit 'no swelling'. All VAS registrations were measured by a ruler to 1.0 mm. Further details concerning patients, surgical procedure, postoperative medication, and registration procedures with regard to the postoperative variables have been described earlier (21).

Statistical methods

Pearson's correlation coefficients (r) were calculated to assess the correlation between the variables. Significance was determined by the one-sample t test.

Differences between individual correlation coefficients were tested for significance by means of Fisher's Z test, and differences between standard deviations were tested with Fisher's variance ratio test.

An ANOVA intraclass correlation analysis was performed to determine the reliability coefficients for assessment of interobserver variation.

Results

None of the participants in this study expressed any difficulties in using a VAS for quantification of swelling.

Table 1 gives an overall view of the scores for different ways of registering swelling. Although the figures are not directly comparable, the metric values for measured extraoral swelling may in this context be regarded as the 'true' values, with which the different VAS registrations should be compared.

It appears that the differences between clinically and photographically assessed swelling are small and insignificant. The significantly lower standard deviations ($p < 0.01$) of these registrations compared with measured extraoral swelling, and the regression lines (general practitioners, $y = 0.43x + 5.5$; oral surgeons, $y = 0.37x + 5.4$) in Fig. 2, indicate that the clinical and photographic assessment methods both tend to underestimate large swellings and slightly overestimate when swelling is small or absent.

Average VAS scores of swelling assessed from photographs by general practitioners and oral surgeons correlated significantly positively with measured swelling, as shown in Table 2. The differences between the two

Table 1. Postoperative swelling (in mm) of 40 patients after surgical removal of impacted lower third molars

	Mean	SD	Range
Measured extraoral swelling	21.3	14.9	2–56
Clinically assessed swelling	14.9	7.2	3–28
Photographically assessed swelling, OS*	13.2	7.6	2–28
Photographically assessed swelling, GP*	14.4	9.2	1–38
Patient self-assessed swelling	18.5	12.3	1–46

* OS = average of assessments by five oral surgeons; GP = average of assessments by five general practitioners.

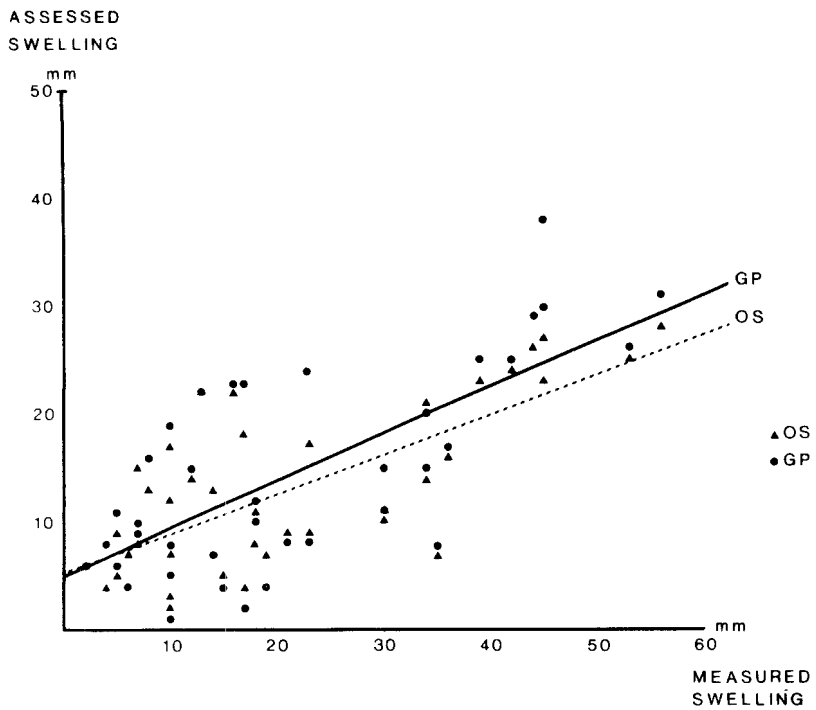

Fig. 2. Relationship between metrically measured swelling and swelling assessed from photographs by two observer groups: general practitioners (GP) ($n = 5$) and oral surgeons (OS) ($n = 5$).

groups of observers were small and insignificant, except for assessment of swelling in male patients. This difference of 0.12 did not, however, reach significance at a 5% level. Corresponding individual observer assessments showed correlation coefficients around 0.6.

Table 3 shows a significantly positive correlation between swelling assessed from photographs and patient self-assessed swelling with a 50-mm VAS. The level of correlation was insignificantly lower than for the relationship between measured swelling and photographically assessed swelling.

Clinically assessed swelling in Table 4 also showed a significantly positive correlation with measured swelling. The correlation level for assessment of swelling in male patients was 0.21 higher than for female patients; this difference does not reach significance at a 5% level. The correlation with patient self-assessed swelling showed a more pronounced difference between male and female patients, amounting to 0.47, which,

Table 2. Correlation coefficients (r) between average VAS scores of swelling assessed from photographs by two groups of observers and measured extraoral swelling

Patients		Swelling assessed by: General practitioners ($n = 5$), r	Swelling assessed by: Oral surgeons ($n = 5$), r
Female	($n = 21$)	0.73**	0.71**
Male	($n = 19$)	0.61**	0.73**
Total	($n = 40$)	0.70**	0.72**

** $p < 0.01$.

Table 3. Assessed swelling from photographs correlated (r) with patients' self-assessment of swelling, both using VAS for registration

Patients		Swelling assessed by: General practitioners ($n = 5$), r	Swelling assessed by: Oral surgeons ($n = 5$), r
Female	($n = 21$)	0.65**	0.66**
Male	($n = 19$)	0.71**	0.69**
Total	($n = 40$)	0.68**	0.66**

** $p < 0.01$.

however, again does not reach significance at a 5% level.

Correlations with swelling assessed from photographs also showed significantly positive values without notable differences between groups of observers or patients.

The correlation coefficient between swelling assessed from photographs by oral surgeons and by general practitioners was 0.89 for male patients, 0.93 for female patients, and 0.92 for the whole group, all reaching significance at a 1% level. This, combined with Fig. 3 (regression line: $y = 1.12x - 0.08$), showed the strong conformity between general practitioners and oral surgeons with regard to assessment of swelling from photographs.

The average scores for swelling assessed from photographs seemed to decrease with lower age of the observers in the group of oral surgeons, whereas the distribution of scores was more even among the general practitioners, as shown in Fig. 4. The standard deviation of average scores for each observer within the group was 3.1 for the general practitioners and 5.0 for the oral surgeons. The difference does not reach significance at a 5% level.

Interobserver reliability coefficients (r_1) were 0.57 for general practitioners ($n = 5$), 0.67 for oral surgeons ($n = 5$), and 0.62 for the combined group ($n = 10$).

Discussion

Clinical evaluation of swelling after third-molar surgery has become discredited as more objective methods of measuring swelling have been developed. Some studies (3, 14) have reported poor accuracy and reliability when comparing observer assessment by means of a VRS with two- or three-dimensional measurements of swelling.

Table 4. Swelling assessed by clinical examination correlated (r) with measured swelling, patient self-assessed swelling, and swelling assessed from photographs

Patients		Swelling: Measured, r	Swelling: Patient-assessed, r	Swelling: Photographically assessed: OS, r	Swelling: Photographically assessed: GP, r
Female	($n = 21$)	0.62**	0.25	0.63**	0.67**
Male	($n = 19$)	0.83**	0.72**	0.70**	0.64**
Total	($n = 40$)	0.71**	0.48**	0.61**	0.63**

** $p < 0.01$.

OS = average of assessments by five oral surgeons; GP = average of assessments by five general practitioners.

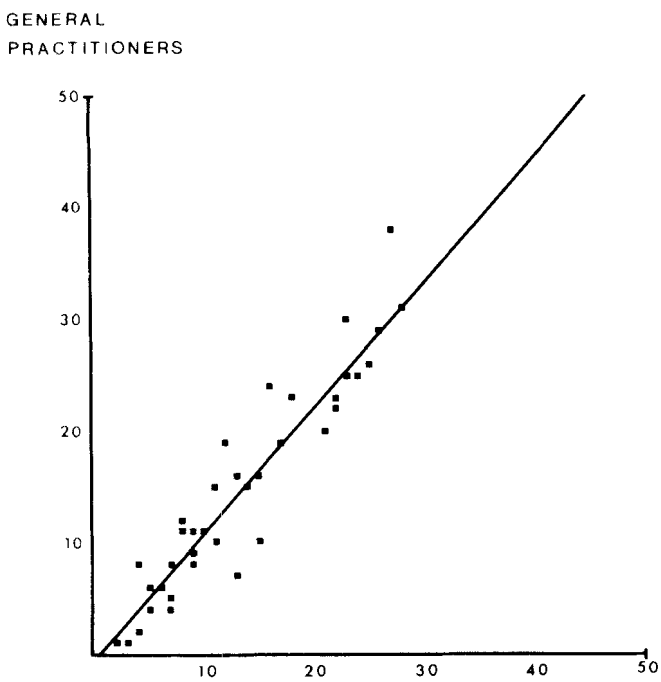

Fig. 3. Relationship between swelling assessed by oral surgeons ($n = 5$) and by general practitioners ($n = 5$), both from photographs.

The present study suggests that clinical evaluation with a VAS may be valid, in accordance with the strong, positive correlation with measured swelling, but less sensitive than metrically measured swelling, in accordance with the tendency for underestimation of large swelling and slight overestimation when swelling is small or absent. It seems to be slightly more difficult to assess swelling in female patients. This may be related to the use of 'covering' makeup and hair-styling on the affected side. As a more lateral view was applied for the clinical examination, this effect seems markedly reduced

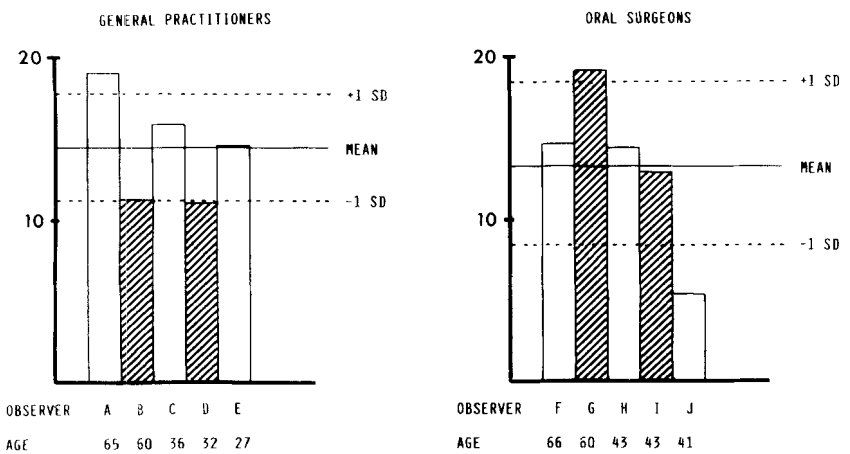

Fig. 4. Swelling assessed from photographs. Distribution of average scores by the two groups of observers, in accordance with the age of the individual observer.

when swelling is evaluated from en-face photographs, in which the unaffected side can be used for direct reference.

The clinical evaluation seems to yield the same degree of validity and sensitivity as the evaluation from photographs. To have access to a three-dimensional view of the patient does not seem to increase the validity of the assessment of swelling.

The clinical evaluation was performed by only one person, and the results will have to be interpreted in this context.

As for the clinical evaluation, the assessment of swelling from photographs seems to show a strong positive correlation with measured swelling, and with a similar compression of the range of observations, resulting from underestimation of large swelling and slight overestimation of small or absent swelling.

Assessments from photographs may have advantages with regard to documentation and the opportunity to increase the number of observers, which seems to increase the level of reliability of the results.

The patient self-assessment of swelling showed correlations to observer-assessed swelling at the same level as earlier reported correlation with measured extraoral swelling (21). Since the standard deviation of the recorded values for self-assessed swelling corresponds to that of measured swelling, this indicates that self-assessment of swelling is as valid as and more sensitive than observer-assessed swelling, whether it be clinically or from photographs.

The conformity of assessments of swelling from photographs by general practitioners and oral surgeons was strong. The small difference, consisting of the oral surgeons' underscore when swelling was large, may be related to the professional situation of oral surgeons, who frequently see patients with extensive swelling. However, this tendency of underestimation seems to decrease with increasing age of the oral surgeons, indicating the effect of cumulative experience in this group. The interobserver variation analysis indicates that the assessments of swelling are slightly more consistent within the group of oral surgeons.

The overall reliability coefficient, combined with the strong positive correlation between the two groups of observers concerning assessment of swelling from the same photographs, indicated that a 50-mm VAS is sufficiently reliable for practical use in clinical research. This is in contradiction to Revill et al. (23), who advised the use of a VAS of at least 100 mm, owing to concern about the increased variance connected to the 50-mm VAS. An increase of correlation beyond the 0.92 found in this study should be considered without practical value in this type of work.

The present study suggests that the previously reported (3, 14) inconsistency between objectively measured swelling and clinically assessed swelling when using a four-graded VRS may be improved by using a VAS and by increasing the number of observers. This again indicates that, as for the evaluation of pain (19, 23), the VAS also has advantages over VRS when assessing swelling.

It can be concluded that the use of VAS improves validity and, to some extent, sensitivity compared with earlier reported VRS when swelling is assessed by observers. Observer-assessed swelling by means of a VAS is less sensitive than three-dimensional mechanically measured swelling and patient self-assessed swelling with a VAS. Only slight differences could be found between general practitioners and oral surgeons with regard to assessment of swelling from photographs, and at 50 mm VAS seems reliable for clinical studies.

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