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CALCULATION OF THE SUBMANDIBULAR GLAND VOLUME BY SIALOGRAPHY

by

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INTRODUCTION

A simple method for calculating the volume of the parotid gland has been presented in an earlier article (*Ericson & Hedin, 1970*). The method was developed to enable a detailed study to be made of the effect of various pathologic conditions and drugs on the volume of the salivary glands and of how the rate of secretion varies with the volume.

The results as regards the parotid gland showed a high correlation between the lateral projection of the area of the gland on sialograms and the total volume ($r^2 = 0.94$), which in turn showed that the deviations in volume were determined almost entirely by the size of the lateral and superficial portion of the gland. By means of regression analysis an expression was derived from which the volume of a particular parotid gland can be calculated with the aid of a constant and knowledge of the extent of the gland expressed as the area of the lateral projection on sialogram. In the present study the method designed in the earlier one was applied to find whether for the submandibular gland, too, there is a relationship between the lateral extent of the gland on a sialogram and its total volume. The method is a combination of a sialographic and planimetric analysis, which is compared with a volume determination.

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MATERIAL AND METHOD

The material for the study consisted of the submandibular glands from 21 cadavers intended for autopsy examinations. None of the subjects had died of any disease known to involve the salivary glands. The examination was performed not later than 16 hours after death.

Sialography. Wharton's duct was located and a polythene tube (PE 50—60) filled with contrast medium was inserted until resistance was felt. To prevent leakage of the medium into the mouth during the injection the tube was sutured to the surrounding soft tissue. The injection of the contrast medium, Lipiodol® (Ethiodol®) was performed manually at a slow rate until a firm resistance was felt — usually after injection of 0.3—0.6 ml.

Sialograms were exposed *in situ* with the cadaver in the supine position. The cassette was placed as near the gland as possible in the sagittal plane, and the central ray was directed laterally on the midpoint of the gland with a focus-to-film distance of 70 cm. The exposure conditions were chosen according to the thickness of the object, which was assessed on the basis of trial exposures. So as to project the gland free of interfering tissues the jaws were closed.

Size determination. 1. The extent of the submandibular gland on the sialogram (in lateral projection) was outlined with a pencil (Fig. 1) and the bounded area was calculated with an Aristo planimeter. The greatest longitudinal and transverse dimensions of the gland were measured.

2. After dissection and removal of the gland (Fig. 2) its volume was determined by water displacement to the nearest 0.1 ml.

Statistics and the error of the method. The range, mean (\bar{x}), difference between the means (d), standard deviation (SD), standard deviation for a single observation (SE), the simple correlation coefficient (r), the total correlation coefficient (R) were calculated by usual methods (Ericson, 1968).

The precision of the planimetric measurements was examined. The lateral projection of the individual submandibular gland on the sialogram was traced and the area determined on two occasions at an interval of 3 months (Areas I and II, respectively).

The range, the mean of the difference Area I *minus* Area II, the simple correlation coefficient and the standard deviation for a single measurement were calculated (Table I). The analysis showed that there was no appreciable difference between Areas I and II. The standard deviation for the random error of the method for a single determination (SE) was 0.28. The error incurred in tracing the gland, was small compared with the range for all the subjects.

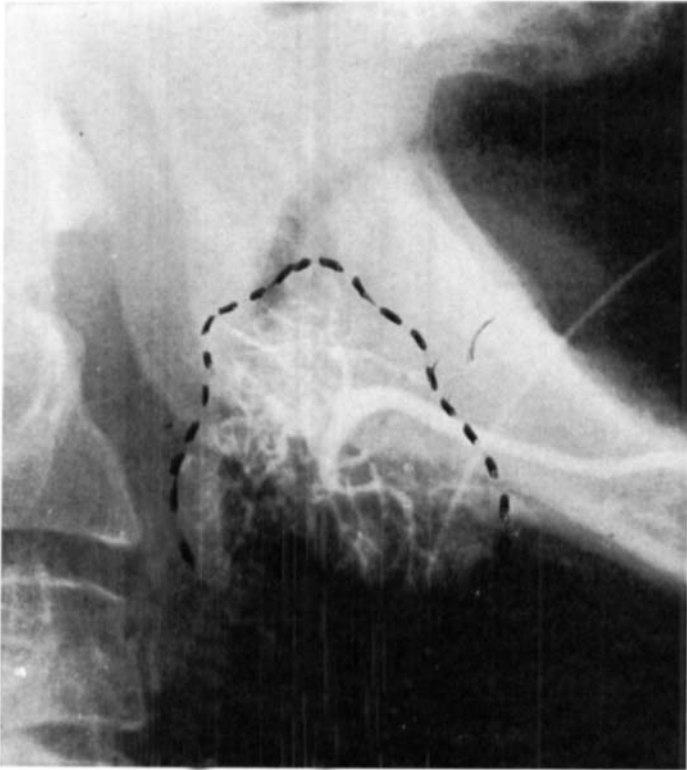


Fig. 1. The extent of the submandibular gland on a sialogram outlined in pencil.

No examination was made of the error incurred in projecting the gland on the X-ray film. Such an examination in respect of the parotid gland disclosed that deviations of the beam amounting to $\pm 3^\circ$ from a zero value were negligible (*Ericson & Hedin, 1970*).

Table I.

Error of the method for a single determination (SE) of the lateral projection of the submandibular gland on sialograms, performed by one investigator on two occasions

| N | Range | | <i>d</i> | | |
|----|----------|----------|-------------------------|------|----------|
| | Area I | Area II | Area I minus Area II | SE | <i>r</i> |
| 21 | 5.8—10.3 | 6.0—10.9 | 0.20 | 0.28 | + 0.97 |

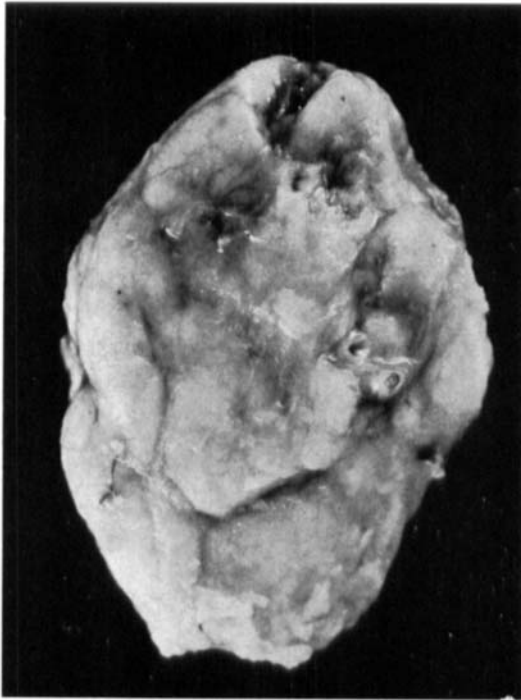


Fig. 2. The dissected submandibular gland.

RESULTS

The means for the volume and area determinations are shown in Table II.

The correlation between the gland volume (V) and its lateral extent on the sialogram (Y) — where $Y = \frac{1}{2}$ (Area I + Area II) — was examined. The coefficient (r) for the simple correlation between the gland volume and the area on the radiograph was $+0.68$. There was thus a positive correlation, though not a particularly close one. The correlation for 21 subjects is shown in Fig. 3.

Table II.

Mean volume of submandibular gland (V ; in millilitres) and area of lateral projection measured on the sialogram (Y ; in square centimetres)

| | Gland volume | Area |
|----|------------------|------------------|
| N | $\bar{x} \pm SD$ | $\bar{x} \pm SD$ |
| 21 | 6.5 ± 2.6 | 8.9 ± 1.2 |

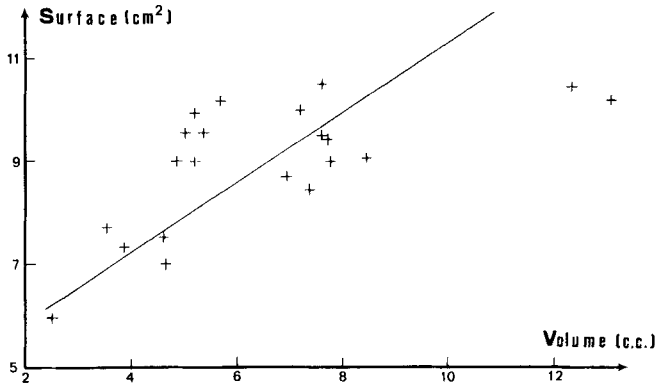


Fig. 3. Correlation between the true volume and the lateral projection of the glands on a sialogram. The regression line $V = -6.64 + 1.47 Y$, where V is the volume and Y the area, has been inserted.

To find whether the breadth or height of the gland on the sialogram, either separately or combined with the lateral projection of the area gave a better estimate of the volume than the lateral area alone a multiple regression analysis was performed with the volume as the regressand and the above variables as the regressors. The volume was found not to be closely correlated to any of the distances or products considered. The product of the length and area was almost as closely correlated with the volume ($r = +0.67$) as the area itself. The age factor — that is, the age of the subject — was found to have no bearing on the results.

To find whether the correlation analyses might be influenced by variations in image quality an examination of the residual variance for individual observations with regard to image quality was performed. The radiographs were divided into three grades with respect to exposure factors and the volume of medium injected compared with the maximum possible volume. For the glands used in the study there was no correlation between image quality and the residual values for the ratio between area and volume. From a regression analysis an expression was derived for the volume of the gland, V ; as a function of its projected area:

$$V = -6.64 + 1.47 Y$$

where Y is the projected area of the individual gland. The standard deviations (SE) for the constants 6.64 and 1.47 were 3.25 and 0.36, respectively. This regression line has been entered in Fig. 3. The square of the total correlation coefficient (R^2) was +0.47.

DISCUSSION

For practical reasons Lipiodol® (Ethiodol®) was used as the contrast medium. The volumes injected were equivalent to those of water-soluble contrast medium found to be clinically suitable for optimal diagnosis. No differences in the visualization of the submandibular gland on the sialogram were found between contrast media that are and are not water-soluble, and it may therefore be inferred that the results are valid for the water-soluble contrast media, which would be preferable in clinical application of the method.

No calculation was made of the volume of contrast medium in the gland when the sialogram was exposed and when the volume of the gland was calculated. The injected quantities were small (0.3–0.6 ml) and an appreciable fraction was possibly located in the actual gland duct. When the gland was removed prior to the volume determination the greater part of the contrast medium ran out. In view of this and the fact that the injected amount was small compared with the volume of the gland, the results cannot have been influenced by the amount of contrast medium injected.

The correlation between the lateral projection of the area and the total volume of the submandibular gland was positive, with $r = +0.68$. The correlation between the area and volume, however, is not strong enough for the area variable alone to be used as a basis for estimating the volume of the gland, as was the case for the parotid gland, where the corresponding value was $+0.96$. It is evident from the coefficient for the correlation between the lateral area and the volume that about 50 per cent of the variation in volume in the material can be attributed to differences in the lateral extent of the submandibular gland. The reason for the difference between the salivary glands in this respect is to be found in the variability of their anatomic shape. For the submandibular gland the third dimension, the thickness, is clearly more variable, and independent of the lateral area; the volume of the gland is thus more dependent on the thickness than is the case for the parotid gland. When the dissected glands were examined, a high or low value for this thickness was found for the glands located farthest from the regression line in Fig. 3.

The projection of the gland in the frontal planes could not be analysed on autopsy series for technical reasons, but in clinical work these projections are not difficult to register, and the volume of the gland may therefore be calculated with a higher level of reliability.

SUMMARY

A method derived for determining the volume of the parotid gland has been applied to the submandibular. The correlation between the volume of this gland and the lateral projection of the gland on a sialogram was weaker than for the parotid gland. A detailed analysis was made of factors conceivably having a bearing on the result. By means of a multiplier a rough estimate of the volume of the submandibular gland can be obtained when the projected area of this gland on the lateral sialogram is known.

RÉSUMÉ

UNE MÉTHODE POUR DÉTERMINER LE VOLUME DE LA GLANDE SOUS-MAXILLAIRE
PAR SIALOGRAPHIE

Une méthode déjà employée pour déterminer le volume de la glande parotide a été appliquée à la glande sous-maxillaire. La corrélation entre le volume de la glande sous-maxillaire et sa superficie en projection latérale telle qu'elle se dessine sur la sialographie n'était pas aussi élevée que pour la glande parotide. Une analyse plus poussée des facteurs pouvant jouer un rôle a été faite. Il est possible d'arriver à une estimation approximative du volume de la glande sous-maxillaire à l'aide d'un multiplicateur quand la superficie de la même glande sur la sialographie latérale est connue.

ZUSAMMENFASSUNG

EINE KLINISCH-RÖNTGENOLOGISCHE STUDIE ÜBER DAS VOLUMEN DER
(GLANDULA) SUBMANDIBULARIS MIT SIALOGRAPHIE

Eine Methode — früher beschrieben — um das Volumen der Parotis zu berechnen ist jetzt auf die Glandula submandibularis gebraucht worden. Die Übereinstimmung zwischen dem Volumen dieser Drüse und ihrer lateralen Projektion — so wie sie sich auf einem Sialogram zeichnet — wurde nicht so gross wie die für Parotis gültig war. Eine nähere Analyse der Faktoren, die möglicherweise das Ergebnis beeinflussen könnten ist ausgeführt worden. Da, wo man die Fläche der Submandibularis auf einem lateralen Sialogram kennt ist es mit Hilfe eines Multiplikators möglich eine approximative Bestimmung des Volumens dieser Drüse zu machen.

REFERENCES

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