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THE RELATIONSHIP BETWEEN RETENTION AND CONVERGENCE ANGLE IN CEMENTED VENEER CROWNS

by

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It is generally known that the smaller the convergence angle between the opposite surfaces of the truncated cone is, the better will the retention be in a cemented veneer crown. So far, however, the relation between these two factors has not been analyzed in laboratory tests.

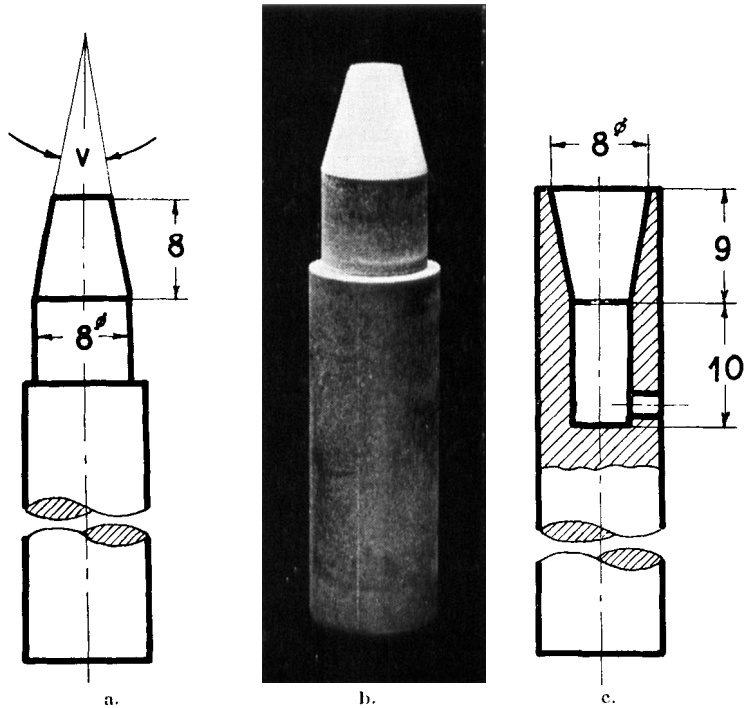
If the retention in g per mm^2 of the conical surface of the truncated cone is plotted as ordinate in a coordinate system with the convergence angle as abscissa (fig. 2), one may expect the relation sought to be expressed by a curve of one of the following three types:

1) The curve begins on the axis of ordinates at a height determined by the experimental conditions. From this point it descends to the right, curving downward as it proceeds. — If the curve has this shape, the retention of the cemented crown will decrease relatively little with beginning deviation from parallelism between the opposite surfaces of the cone.

2) The curve describes a straight line from a point on the axis of ordinates to a point on the axis of abscissas. — In this case the retention of the crown will decrease gradually with an increase of the convergence angle.

3) The curve takes the course shown in fig. 2. — The retention of the crown will decrease considerably at beginning deviation from parallelism between the opposite surfaces of the cone.

The actual relation between the two abovementioned variables was shown in the following way:



a. b. c.

Fig. 1. Truncated cone and cap, as used in the experiments; v indicates the convergence angle of the cone.

Instead of natural teeth cones of galalith were used; they had the following dimensions (fig. 1 a): The base was 8 mm in diameter and 8 mm in height; the vertical angle of the cone (the convergence angle) had the values 5, 10, 15, 20, 25, 35 or 45°. The cones were made on a lathe to an accuracy of ± 0.005 mm. In order to ensure uniform surfaces the same turning tool and, as far as possible, the same turning technic were used for all the cones. The surface was in every case dull and without visible turning marks. For each vertical angle 10 cones were made. The cones were provided with handles so that they could be mounted in the machine for tensile testing.

Instead of cast crowns brass caps were used. Like the cones their inside surfaces were turned with the same tool and at the same speed. For each vertical angle 3 caps were made. As it was desired to examine the retention between the oblique surfaces of the cone and the cap only, a cylindrical hole was made

in continuation of the conical bore of the cap (fig. 1 c). The cap also was provided with a handle, so that it could be mounted in the testing machine.

The same brand of phosphate cement was used for all the cementations, in a mixing proportion to give normal consistency according to A.D.A. specification No. 8. Spatulation and cementation were performed according to a standardized technic. The cementation pressure, which amounted to 4 kg in the standard experiments, was maintained for 10 minutes. – – In order to prevent the excess cement that was pressed out into the cylindrical part of the brass cap from influencing the results of the tensile tests, the end surfaces of the cones were waxed before cementation. To avoid errors in the cementation pressure, a transversal bore leading from the cylindrical bore in the caps to their external surfaces was made to provide an outlet for entrapped air (fig. 1 c).

The retention between the oblique surfaces of the cone and the cap was measured 24 hours after cementation by pulling them apart. The tensile tests were made in a Losenhausen testing machine (maximum 1,000 kg). The rate of pull was ca. 500 g per sec.

The experimental results are shown in table I.

Table I

Convergence angle	n	M kg	ε	σ	A mm^2	M ÷ A g/mm^2
5°	10	15.62	1.57	4.95	192	81.3
10°	10	7 62	1.20	3.78	184	41.4
15°	9	6.22	0.96	2.89	176	35.3
20°	10	4.31	0.97	3.08	168	25.7
25°	10	2.76	0.61	1.92	160	17.3
35°	10	2.60	0.73	2.30	144	18.1
45°	10	1.53	0.40	1.25	112	13.7

n indicates the number of tensile tests, M the mean value, ε the standard error of the mean, σ the standard deviation, A the surface area of the cone in mm^2 and M ÷ A the mean value of the retention in g/mm^2.

The relation between M ÷ A and the convergence is presented in the coordinate system in fig. 2 as open circles. The curve by

which they are coordinated is a hyperbola. Its formula from the values at 5° and 45° is computed to be $(y - 5.5) \cdot x = 380$. By means of this formula the ordinate values for convergence angles of 2°, 3°, 60° and 90° were computed and plotted in the coordinate system (crosses).

A small number of tensile tests were made after cementation pressures of 0.5 kg or 10 kg. For the lower pressure it was found that the retention value for each angle of convergence was within the tabulated values for $M \pm \sigma$, while the values for the higher cementation pressure in every case exceeded the tabulated value for $M \pm \sigma$.

The influence of the smoothness of the surface was examined by scratching the inside surface of the brass cap with a piece of sand paper No. 0. The scratching was so slight as to be scarcely visible to the naked eye. It was performed with the caps fixed in the lathe, and the time and pressure of the scratching were made as uniform as possible. Only the brass surface was scratched, because the preceding experiments had shown that the cement always adhered to the cone after the tension tests.

The results of the tensile tests with scratched brass caps are shown in table II.

Table II

Convergence angle	n	M kg	ε	σ	A mm^2	M ÷ A g/mm^2
5°	10	24.91	1.73	5.48	192	129.7
10°	10	19.52	0.67	2.13	184	106.1
15°	10	19.36	1.66	5.26	176	110.0
20°	10	18.46	1.63	5.15	168	109.9
25°	10	8.70	1.16	3.65	160	54.4
35°	10	13.76	1.66	5.23	144	95.6
45°	10	6.43	0.75	2.38	112	57.4

Table II shows in every case a substantial increase in the retention, as compared with the corresponding figures for non-scratched caps. Further it will be seen (figure 2, filled circles) that no regular relationship was found between convergence angle and retention. This is undoubtedly due to the fact that the

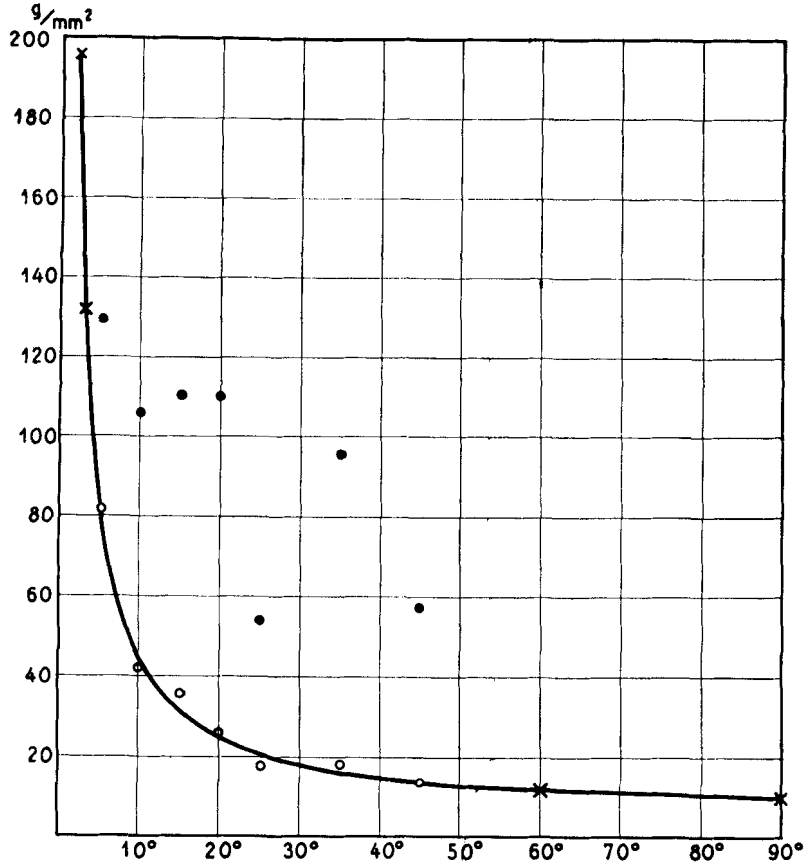


Fig. 2. The relation between the retention and the convergence angle in cemented veneer crowns.
Open circles: The mean value found for the retention in non-scratched crowns.
Crosses: Calculated values outside the experimental range.
Filled circles: The mean value found for the retention in scratched crowns.

degree of roughness on the inside surface of the brass caps was not standardized. The author knows of no method of standardizing the scratching of surfaces of the type in question.

SUMMARY

A report is given of some investigations on the relationship between the retentive force and the angle of convergence in cemented veneer crowns. The relation is shown to be a hyperbola

(fig. 2) with the formula $(y - a) \cdot x = K$, where y is the retention in g per mm², x the convergence angle, and a and K constants. The retention is substantially increased by a very slight scratching of the surfaces that are to be cemented together.

RÉSUMÉ

LE RAPPORT ENTRE LA FORCE DE RETENTION ET L'ANGLE DE CONVERGENCE DES COURONNES COULÉES

Certaines études sur le rapport entre la force de retention et l'angle de convergence des couronnes cimentées sont présentées. Ce rapport est décrit (fig. 2) par l'hyperbole $(y - a) \cdot x = K$, où y représente la retention en gm. per mm², x est l'angle de convergence, et où a et K sont des constans. La retention est sensiblement augmentée en grattant très légèrement les surfaces à être cimentées.

ZUSAMMENFASSUNG

DIE RELATION ZWISCHEN RETENTION UND KONVERGENZWINKEL GEGOSSENER VOLLKRONEN

Die Ergebnisse einer Untersuchung über die Relation zwischen Retention und Konvergenzwinkel gegossener Vollkronen werden mitgeteilt. — Die Relation ist eine Hyperbel (fig. 2) mit der Formel $(y - a) \cdot x = K$, wo y die Retention in g pro mm² ist, x der Konvergenzwinkel; a und K sind Konstanten. Die Retention wird durch schwaches Ritzen der zusammenzementierten Flächen wesentlich verstärkt.

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