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CRDs: CAST OR PREFABRICATED?

PART II

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ABSTRACT. Clinical experience confirms data in the literature according to which cast and prefabricated metallic CRDs sooner or later produce dental or CRD fractures. In this paper we confined our study to CRDs cast in a laboratory and prefabricated Dentatus CRDs. We sought to highlight their traumatogenic potential during tooth preparation, device aggregation, and normal and parafunctional use. To this end we used the elasticimetry and tensometry method. The results are very conclusive and allow practitioners to act discerningly in the case of coronal substitution.
KEYWORDS: CRD, photo-elasticimetry, tensometry.

INTRODUCTION.

From the study of specialized literature and our own clinical study on 186 patients, some of which were presented in the 1st part of the research, it became apparent that CRD aggregation causes strains on fragile dental walls, which can crack, and during functions and especially parafunctions, they end up as fractured. This research targets cast and prefabricated metallic Dentatus CRDs.

A cast CRD is passive, dental fractures occurring mostly due to inappropriate treatment indication, inappropriate technique for intra-radicular preparation, insufficient cervical support, or unexpected cementing.

In the case of prefabricated Dentatus devices, vastly employed in our country in recent years, we noted frequent cases of failure, the most severe of which are radicular perforation and oblique or longitudinal tooth fracture.

These devices are cylindrical-conical with a conical tip, have a screw, and the coronal portion is cuboidal, with a simple rift, or crosswise, necessary for screwing. It is a screwed-on passive device, but through its shape it exerts a puncture effect on the root during aggregation, functions and parafunctions.

They are found in toolkits, in six diameters, four lengths and two screw wrenches. They correspond to special milling cutters for preparing the radicular slot.

Devices are cemented in spite of not having a discharge rift.

Purpose of paper. In order to check whether the use of this device system generates tensions in radicular tissues, we conducted an "in vitro" study using the photo-elasticimetry and tensometry method. Mahler and Peyton stated that this method is applicable to the study of dental structure of varying shape and weight and irregular form.

In vitro study of the behavior of dental tissues in strains related to cast and prefabricated Dentatus CRDs

MATERIAL AND METHODS

Photo-elasticimetry is an experimental method with which areas of tension and deformation in bodies subject to stress are highlighted. It is based on the accidental bi-refringence property of some materials.

A luminous monochromatic vibration, polarized by a polarizer, must pass through such photo-elastic element. Luminous vibration is decomposed into two components: isoclines and isochromates (optical bands).

Isochromates are easily observed as being colored bands, the more intense and denser the more the bodies are strained.

For this study we chose a rectangular plexiglas plate with high elastic sensitivity (Dinox)(fig. 1).

To begin with, traces of technological tension were found in the plate.

Under the lens of the apparatus, depressions were made, using globular milling cutters, on the upper part of the plate, then 10 mm deep slots were dug with milling cutters from the Dentatus toolkit, in successive order up to the number 4.

During this maneuver, the appearance of isochromates was observed around the slot, being more intense and more numerous as the pressure applied to the counter-angle piece and implicitly the milling cutter was higher.

The plate was then put in an oven, where it underwent thermal treatment to relieve stress and so that the material might subsequently form a maximum of optical bands. Models were examined at the polariscope before the aggregation of devices.

Next the Dentatus device (gold-plated brass) was aggregated into the slot, with cement interposition. If the device is screwed on to the maximum, tensions represented by isochromates appear around the tip of the device.

On de-rotation by 90 degrees, isochromates are greatly reduced.

A progressive compression force in the axis of the tooth was exerted on the coronal portion of the device, reaching 284 N with the aid of a loading device (fig.2).

The appearance and enhancement of isochromates was observed, especially around the apex of the device.

If pressure is exerted obliquely (30 degrees), isochromates are enhanced in the upper area of the plate, opposite the site of application of the force and in the area of the tip of the device, on the side of the force. The color of bands ranges from red to green.

The same experiment was conducted with Radix Anchor screwed-on device. It features a higher stress concentration during aggregation than Dentatus, which increases substantially on vertical or oblique loading. This concentration is higher in the apex for Dentatus and in the proximity of Radix Anchor coils.

On oblique compression, stress concentration increases on the compressed side, which was higher for Radix.

This same thing was done with cast CRDs.

RESULTS AND DISCUSSIONS

This method was used in order to analyze the force at which human teeth are cracked or fractured, but it was proven, according to Reinhardt's assertions, that it is difficult to prepare complex models from materials with the elasticity module of human dentin.

Isochromates that appear in strained areas express qualitative and not quantitative changes, but confirm the fact that prefabricated devices can produce tensions during intra-radicular aggregation and later during mastication or bruxism, which might generate radicular fractures.

Another reason why the qualitative analysis was used is that the reflection polariscope is only equipped with one source of white light. This led to highlighting a colored pattern that makes quantitative analysis difficult. Moreover, the color analysis method is not very accurate for quantitative analysis, as it depends on the observer's sensitivity to slight changes in color.

The method provided instead an acceptable, visual qualitative analysis.

This investigation is the starting point for other analyses of stress induced by CRD aggregation (analysis of finite element method, tensometry).

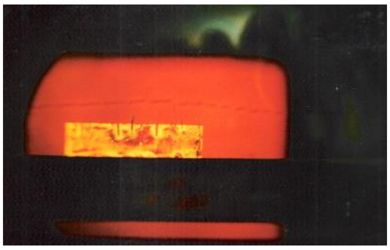
fig. 1

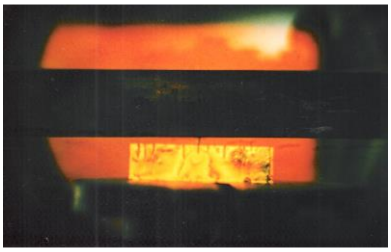
fig. 2

"In vitro" study of the behavior of hard dental tissues at strains related to cast and prefabricated Dentatus CRDs using tensiometry

In order to obtain quantitative values of tension, highlighted with photo-elasticimetry, we conducted a test where we used another experimental method to gauge tensions in strained bodies, namely tensometry.

MATERIAL AND METHOD

Tensometry is a set of methods and techniques that deals with measuring small deformations on the surface of strained bodies. Among these methods, we used resistive electric tensometry, which electrically measures non-electric quantities, namely: deformations of a strained body. The method was used in dental research before, but less in the field of CRDs.

Measuring is carried out with the aid of an electric transmitter, or tensometric timbre, which transforms deformations into electrical quantities (Fig.3).

The tensometric timbre is linked by wires to the recording block of deformations, or tensometric bridge.

In the case of our "in vitro" experiment, detecting tensions and implicitly the optimal momentum of Dentatus device aggregation, the issue of RET placement was raised. The chosen solution was placing them on both sides of an elastic slide adapted on a dynamometric wrench.

40 monoradicular teeth were selected for the experiment, of comparable sizes (conserved in formalin), which were immersed in blocks of polymeric resin up to the tooth neck (Fig. nr. 4). The coronal portion was cut 2 mm above the tooth neck. Then intra-radicular slots were prepared using milling cutters from the toolkit, in successive order up to the number 4. Dentatus no. 4 were aggregated.

Throughout the experiment, teeth were kept in saline solution.

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A dynamometric wrench was designed to aggregate devices and gauge tensions, measured in Nmm.

The wrench consists of a (transversal) lever blade, which has a nut at one end and horizontally fixed to an external cylindrical and striated portion of the wrench of the device, and a sharp blade at the other end (Fig. 3, 4).

Momentum is loaded into the wrench by placing the lever blade on the striated part of the wrench. Engagement is made by a light tipping movement of the lever in the plane of the wrench axis. The maneuver angle can be limited to 20-30 degrees to allow its subsequent use in the oral cavity, where it would not have room for complete rotation. The lever blade can be repositioned and the movement can be repeated whenever necessary.

The tension momentum is captured by mounting two RETs, tl and t2, to the end zone of the lever, where the value of the bending momentum on its body is maximum. The mounting of TERs is a Wheatstone bridge, coupled to an AM tensiometric amplifier, with Ii indicating instrument (Fig. 5).

The amplifier and instrument were calibrated using a weight hung from the lever's end, in position with the horizontal blade.

The instrument's amplification was set so as the scale end would represent 20 Nmm.

Tests were done on teeth prepared beforehand, divided into 4 lots of 10 each.

With the first lot, the correlation of the perception of final device aggregation to the indication of the gauging device was measured.

To this end, the device was inserted in the canal and manual rotation movement was executed until the perception of locking. At this moment the dynamometric wrench was applied, with which two-three 20-30 degree movements were executed, until the moment of final locking was perceived. This corresponds to a rotation of approximately 360 degrees. Both the aggregation and the momentum reading were carried out by the operator.

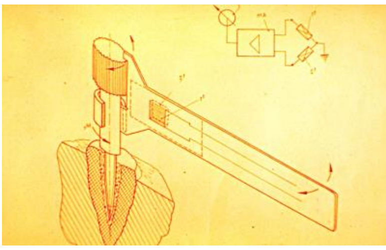

fig 3 Dynamometric wrench with tensiometric timbre

fig.4 Dentatus teeth prepared for experiment.

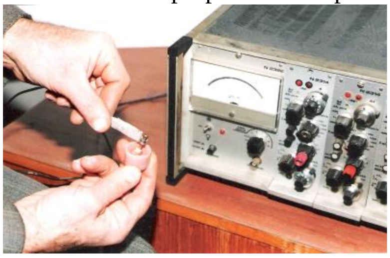

fig. 5. Capturing tension momentum.

The following objective was to perceive (by touch) and read the moment of device locking on the scale of the apparatus. This moment approximately corresponds to a 90-degree de-rotation. Results obtained in this lot with the two maneuvers are shown in table 1.

- Another lot of teeth was prepared and tested similarly to the first, the difference being in that the operator executed the aggregation and the aid read the results (table 2).
- For the third lot the device aggregation technique was changed. The device was vertically inserted in the canal, then the dynamometric wrench was applied, and in it a rotation movement of approximately 45° and then up to 180° was executed.

Results are shown in table 3.

- On a fourth lot this last device aggregation technique was utilized, after inserting a zinc oxyphosphate cement paste in the canal.

Rotation moments were recorded at 45° and at 180°, as well as on a rotation movement.

		Teeth	Stroke 1	Stroke 1

			Locking or rotation moment (in Nmm)	Locking or de-rotation moment (in Nmm)
Group I	Freshly extracted teeth (saline solution 3-5 h)	1	15	12
		2	12	8
		3	9	6
		4	10	7
		5	7.5	3
Group II	Teeth preserved in formalin 10%	1	20	14
		2	14	9
		3	6	3.5
		4	13.5	7
		5	8	5

Table 1

		Teeth	Stroke 1	Stroke 1
			Locking or rotation moment (in Nmm)	Locking or de-rotation moment (in Nmm)
Group I	Freshly extracted teeth (saline solution 3-5 h)	1	5	3
		2	6	7
		3	3	0.5
		4	2.5	2
		5	3.5	2
Group II	Teeth preserved in formalin 10%	1	4.5	4
		2	5	3
		3	6	7
		4	5.5	5
		5	4	2.5

Table 2

		Teeth	Stroke 1	Stroke 1
			Locking or rotation moment (in Nmm)	Locking or de-rotation moment (in Nmm)
Group I	Freshly extracted teeth (saline solution 3-5 h)	1	15	4
		2	12	5
		3	9	4
		4	10	7
		5	7.5	5
Group II	Teeth preserved in formalin 10%	1	2.5	3
		2	2	5
		3	3	1
		4	1.5	1
		5	1	2.5

Table 3

		Teeth	Moment during cementing (in Nmm) at 45 degrees	At 90 degrees	Unlocking
Group I	Freshly extracted teeth (saline solution 3-5 h)	1	1	0	8
		2	3	0	9
		3	1	7	9
		4	2	5	8
		5	1.5	5	6
Group II	Teeth preserved in formalin 10%	1	1.5	3.5	6.5
		2	0.5	3	10
		3	2	5	9
		4	3	6.5	10
		5	2.5	6	9

Table 4

The same was also done with cast CRDs.

RESULTS AND DISCUSSIONS

l. The first table shows that the values of the final aggregation momentum range between:

- 7-15 Nmm in group I and
- 6-15 Nmm, with one exception, in group II.

On untightening by approximately 90 degrees, values of the momentum range between:

- 3 and 12 Nmm in group I
- 3.5 and 14 Nmm in group II.

See tables1, 2, 3.

This shows large and different values within the same group of teeth, but also similar comparing the two lots.

We conclude that the aggregation technique up to the perception of the device locking moment is relative and different from one practitioner to another, or even for the same practitioner from one moment to another. Causes can be multiple: muscular force varying from one person to another, different tactile perception threshold, influence of fatigue, stress, nervousness, etc.

Since the structure of dental tissues is approximately the same, it cannot constitute the cause of differences.

During device de-rotation, the value of the momentum decreases, but we assume that it is still too large.

2. Values in table 2 range between:

- 2.5 and 6 Nmm in group I, at maximum rotation
- 4 and 6 Nmm in group II, at maximum rotation
- 0.5 and 7 Nmm in group I, at de-rotation by 90 degrees
- 2.5 and 7 Nmm in group II, at de-rotation by 90 degrees

These values are much lower than the ones in din table 1 and are the real ones.

The explanation is as follows: on the first testing since the moment of perception of the maximum device aggregation by the operator and the moment of shifting glance to the gauge, the dosage of muscular force escapes control, so that the tendency to tighten the device further appears.

Likewise, we noted that the practitioner feels tempted to reach the values of first testing. The untightening moment also has low values, so dental tensions are greatly reduced.

3. Table 3 shows values of the moment of 45 degree rotation, the values are low, and thus tensions are also low, but device retention is reduced.

- 1.5 and 4 Nmm in group I
- 1 and 3 Nmm in group II

On rotation by 180 degrees, device retention is better, and moment values range between:

- 4 and 7 Nmm in group I
- 1 and 5 Nmm in group II

Comparing the results of test 2 with 3, it follows that the first aggregation technique yields good device retention, but is stressful for dental tissues during maximum aggregation. The second technique is less retentive for the device, and exerts lower pressure on dental tissues.

Hence, final optimal aggregation is obtained by rotating the wrench between 180-270 degrees.

Table 4 leads to the following conclusions:

Tensions during cementing, on rotation by 45 degrees, are insignificant:

- 1 and 3 Nmm in group I
- 0.5 and 3 Nmm in group II.

On rotation by 180 degrees, values range between:

- 0 and 7 Nmm in group I
- 3 and 6.5 Nmm in group II and are close to the ones in table 2 and 3.

This leads us to the conclusion that cement in fluid state has a role of dispersion of tensions, even though the device has no discharge rifts.

CONCLUSIONS

- The stress characteristics of devices result from their design.
- Devices generally concentrate stress in their site of contact with the walls of the radicular slot.
- Screwless devices have clearly produced high apical stress, in all tested situations.
- Screwed-on devices concentrate stress under the clamps and in the coils, in all testing conditions.

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