Cast posts: a 44-year retrospective clinical study in a specialized private clinic

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Abstract

Aim. The aim of this study was to examine the longitudinal clinical result of the use of cast posts and cores and crown restorations in endodontically treated teeth over a 44-year period. **Materials and methods.** Out of 130 randomly selected patients, 95 had had 297 teeth rehabilitated with cast posts and cores and crown restorations. The endodontic rehabilitation was considered successful when the tooth remained functional with no clinical or radiographic pathology. **Results.** The success rate was 90% (268) and the failure rate 10% (29). Cohen's Kappa index ranged between 0.78 and 1. **Conclusions.** In this 44-year retrospective study, the clinical success rate was 90%. The mean survival time of the studied teeth was 19 years. The failure rate was 10%; tooth fractures were the most prevalent failures (5% of all restored teeth).

Keywords: Endodontically treated teeth, Root anchorage, Tooth fracture, Bruxism, Clinical success.

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Introduction

Endodontically treated teeth (ETT) are often structurally compromised due to several factors (1-4). ETTs may be restored with cast posts, which provide adequate retention for crowns restorations or fixed dental prostheses (FDPs) (5, 6).

Cast posts rate of success varies according to the literature, biomechanical failures being the most common ones. Post loosening and tooth fractures are the most frequent failures (7-11). Recurrent caries and apical periodontitis are less prevalent (9, 12).

Long-term (over 10 years) longitudinal clinical studies are rare. Five such studies showed varying degrees of success ranging from 55% to 94% (9.11-13.59). This lack of long-term studies and the varying results reported make the analysis of a 44-year study documented clinical results particularly interesting.

The aim of this retrospective investigation was to evaluate the longitudinal clinical outcomes of cast posts and cores used in the rehabilitation of ETTs as carried out by the first author in his private practice for 44 years.

Materials and methods

The Inclusion Criteria for the sample was that the patients to be evaluated must have attended the first author's clinic for at least 3 years and they had to be current patients.

Out of 2552 registered patients, excluding those who had moved or passed away, 210 met this requirement. Of these, 140 patients were selected at random by a dental assistant, who did not know the aim of the selection. This sample was considered appropriate by the authors. These 140 patients were invited to a clinical examination between November 2013 and April 2014: 130 agreed to participate while 10 declined for personal reasons. Among the examined patients, 95 had ETTs,

in total 297 cast posts and cores in noble alloy. All the clinical restorations were carried out by one operator (the first author). The co-authors participated as independent evaluators. The calibration between the evaluators and the first author was carried out previously on 120 restorative procedures outside the sample. The quality analysis of the restorations was based on modified Ryge (14) criteria (Table1). Cohen's Kappa Coefficient ranged between 0.78 and 1 (15), which is rated as excellent in the Fleiss Guide (16).

MARGINAL ADAPTATION
ALPHA: No lack of continuity along the margin between the restoration and the tooth perceived with the explorer.
BRAVO: Evidence of a crevice along the margin into which an explorer does not penetrate.
CHARLIE: Evidence of a crevice along the margin with exposed dentin/base which an explorer penetrates. Requires control, repair or retreatment.
DELTA: Similar to Charlie but with mobility or fracture of the restoration. Requires retreatment.
MARGINAL DISCOLORATION
ALPHA: No pigmentation anywhere on the margin between the restoration and the tooth.
BRAVO: Pigmentation present but does not penetrate along the margin toward the pulp.
CHARLIE: Severe pigmentation. The restoration must be removed.
SURFACE
ALPHA: The surface of the restoration is unaltered.
BRAVO: The surface of the restoration shows wear that alters its morphology. Must be controlled.
CHARLIE: The surface of the restoration shows perforations, fractures or significant tear.
Must be polished, repaired or retreated.
DELTA: The surface is altered or fractured and needs retreatment.

Table 1 Modified Ryge criteria

Patient-based data collected from the clinical history and the examination were registered on specially designed forms. The patients were examined clinically and radiographically. In case of disagreement regarding the assessment of the quality of restorations, the lowest rating was assigned.

The inclusion criteria applied for the cast posts were as follow:

- The post under study had to have been functional for at least two years, in individual teeth or abutments of fixed dental prosthesis (FDPs).

- Having X-ray tests of the teeth under study taken in the last 12 months.

- One-piece gold onlay and metal ceramic crown with posts were taken as cast posts.

- Existing cast posts not made by the operator but which he deemed acceptable for crown retreatment were included from the moment the new rehabilitation was placed.

The success criteria for the cast posts and cores were as follows:

- ETT rehabilitated with a cast post and a crown restoration was still clinically in function and pathology-free.

- Radiographic examination of the rehabilitated ETT did not show apical pathology.

When preparing the tooth, the author: tried to preserve the maximum amount of coronal dentin; avoided drilling the root canal more than one third of the mesial-distal width of the root; tried to preserve at least 4 mm of remaining apical endodontic sealing and to reach a post crown-root ratio of 1-1 to 1-1.5 when possible.

Variables analyzed: age, sex, X-ray tests, distribution in the dental arches, type of cement, decay, parafunctional habits, maintenance therapy, success, failures and survival of cast posts.

Data processing was done using Epidat 3.1 software developed by the Consellería de Sanidade de la Xunta de Galicia with the sup-port of PAHO-WHO and SPPS 13.0. In all cases, the variables considered were taken as corresponding to an identically distributed independent random variable, generated from a probability sample. A result is considered statistically relevant when, upon the rejection of a null hypothesis, the probability of error is below 5%. Statistical significance was set at $P< 0.05$. When analyzing the complete and censored values, the mean and the median were used to describe the central tendency.

Results

The sample consisted of 70 women and 25 men, with a ratio of 2.8 women/men. The median age was 67 in women (range: 40 to 80) and 69 in men (range: 42 to 71), there being no statistically significant differences between the sexes. The treatment period for these patients varied between 3 and 44 years. The average period was 27 years.

Out of 297 cast posts, 268 (90%) were still functional. Twenty-nine (10%) failed: 19 in single teeth and 10 in abutments of FDPs. The number of and reasons for failure are shown in Fig 1. Twenty-six teeth (9%) were lost.
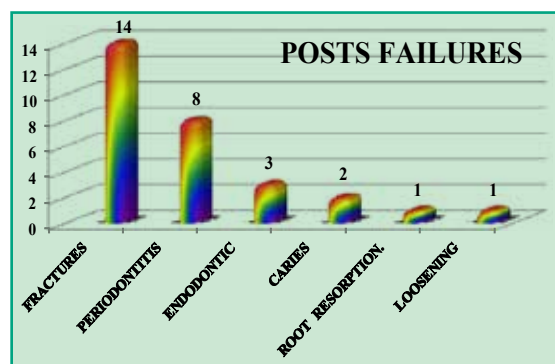
Fig. 1: Posts failures: number and reasons

The radiographic examination showed apical radiolucencies in three patients, which were considered non-pathological since they showed no macroscopic variations in 9, 21, and 23-year periods respectively (17). It was also noted that three chronic periapical processes which had been treated by means of apicoectomies had healed.

During the follow-up period, caries was found in only one crown restoration (0.4%) of the functioning teeth: the lesion was treated conserving the original treatment.

All of the 22 existing posts used were still in function but it was not possible to know the alloy type. The other 246 functioning casts made by the first author were cast in gold alloy type III or noble alloy (Ag, Pd, Au). All cast posts and cores were luted with zinc phosphate cement and one loosened (0.4%): a new cast post and core was placed.

At the time of the evaluation, two aluminous porcelain crowns on the same patient, with a survival time of 38 years and 7 months, fractured and had to be replaced with metal-free ceramic crowns, while maintaining the existing cast posts.

The 266 functional crown restorations were distributed as follows: 189 single full crown restorations, 65 abutments of FDPs and 12 crown-root restorations in one piece (8 onlays in gold alloy type III and 4 metal-ceramic crowns in gold (Au, Pd) or noble alloy (Ag, Pd)). According to modified Ryge criteria (14), the quality of these restorations is presented in Table 2. The combined quality analysis of each restoration showed that 255 (95%) restorations reached levels of clinical acceptance (rate: Alpha or Bravo in marginal adaptation, marginal discoloration and surface).

	MARGINAL ADAPTATION	MARGINAL DISCOLORATION	SURFACE
Alpha	162	258	247
Bravo	101	8	11
Charlie	3	0	8

Table 2: Quality of restorations according to modified Ryge criteria (in number)

Two hundred and ninety-seven posts under study were between 31 months (2 years, 7 months) and 532 months (44 years, 4 months) old.

The observed survival time of the posts may be broken down as follows:

- The 268 posts which were still functional had an average survival time of 231 months (19 years, 3 months), and the upper quartile of 388 months (32 years, 4 months). Of the cast posts still in function, the survival time was >20 years for 49%, between 10 and 20 years for 32%, and <10 years for 19% (Fig. 2).
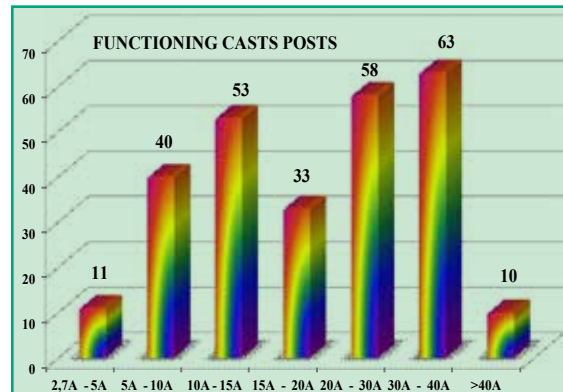
Fig. 2: Survival time of functioning cast posts in function

- The observed survival time of the 29 cast posts that failed was 208 months (17 years, 4 months), and the upper quartile of 282 months (23 years, 6 months). Of the 14 fractures, 43% had a survival time of between 20 and 28 years, 36% between 10 and 20 years, and 21% less than 10 years (Fig. 3).
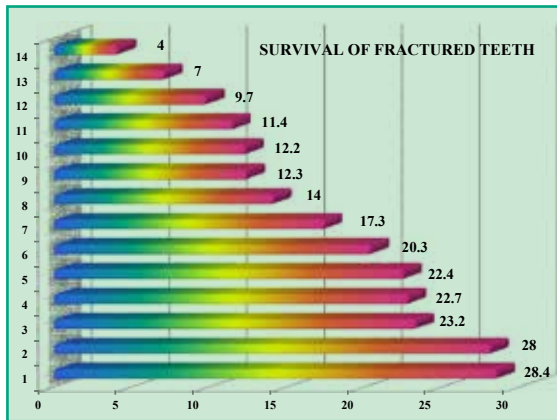
Fig. 3: Survival time of each fractured tooth (in years)

There was no difference in survival rate of cast posts between men and women (Mantel-Cox Log-Rank test "P" = 0.54).

The distribution of the 297 cast posts in the dental arches is shown in Fig. 4. The mandibular incisors and premolars were the most seldom treated teeth, whereas the distribution of the cast posts was similar in the other groups of teeth.
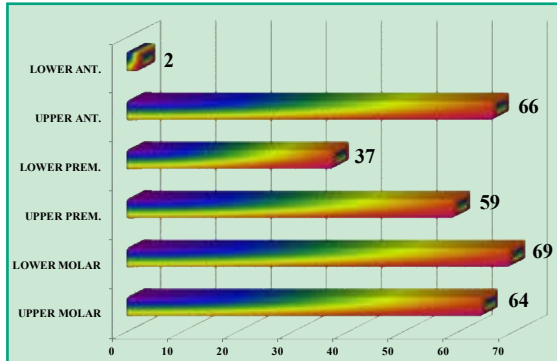

Fig. 4: Distribution of the 297 cast posts in the dental arches

Of the 14 tooth fractures, 5 occurred in the maxillary anterior and 5 in the maxillary premolar teeth, whereas 4 occurred in the molars, two in each jaw.

At the clinical evaluation, 20 asymptomatic patients had parafunctional wear facets (the activity was not assessed); 26 reported nocturnal bruxism and were using occlusal stabilization splints; 6 were being treated for signs and symptoms of Temporo- Mandibular-Disorders (TMD) with occlusal devices and other therapies; and 17 had been in treatment for bruxism.

If these 4 groups of patients are considered jointly, 69 of the 95 patients (73%) have or had a history of parafunction in the observed period. Patients with reported parafunction had statistically significantly lower survival rate of cast posts than those without parafunctional habits. (Mantel-Cox Log-Rank test "P" = 0.020) (Fig. 5).
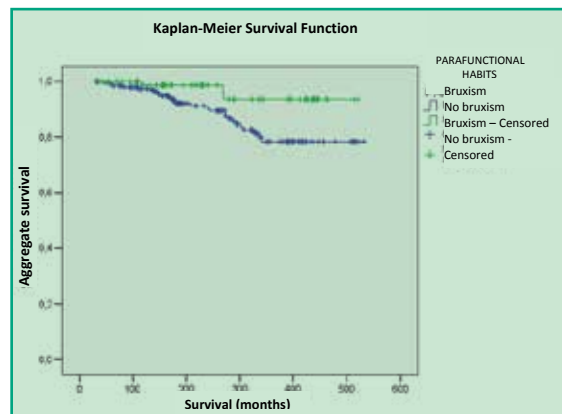
Fig. 5: Compared survival rate of cast posts in patients with and without bruxism

The survival rate of the cast posts fit a multivariate Cox regression model (Table 3), including sex, age, bruxism and maintenance as explanatory variables (Chi-square omnibus test "P" = 0.01). The older the patient, the lower the survival rate of the ETT. Women showed a higher survival rate than men.

					Confidence interval 95% Exp(B)	
	B	SE	Level of significance		Ext. lower	Ext. upper
Age	-0.031	0.020	0.132	0.970	0.932	1.009
Maintenance	0.745	0.375	0.047	2.106	1.009	4.393
Bruxism	1.138	0.618	0.065	3.120	0.929	10.483
Gender	0.328	0.407	0.421	1.388	0.625	3.082

Table 3: Survival of cast posts: Multivariate logistical Cox regression model considering four variables

Survival rates of cast posts are aligned with a simpler logistical Cox regression model (Table 4), with bruxism and maintenance as explanatory variables (Chi-square omnibus test "P" =0.009).

					Confidence interval 95% Exp(B)	
	B	SE	Level of significance	Exp(B)	Ext. lower	Ext. upper
Bruxism	1.216	0.613	0.047	3.372	1.014	11.209
Maintenance	0.722	0.376	0.055	2.058	0.985	4.299

Table 4: Survival of cast posts: Multivariate logistical Cox regression model considering two variables

There was a statistically significant relationship between bruxism and ETT survival time, both at univariate (Mantel-Cox test "P" = 0.02) and multivariate levels (Cox regression model "P"=0.047). The probability of a lower survival rate for ETTs among patients with bruxism was 3.37 times higher than for patients without a diagnosis of bruxism.

Only 37 patients (39%) attended at least once a year to receive maintenance therapy. ETTs with no maintenance showed a higher survival rate ("P"= 0.055) than those who had maintenance. However, out of a total of 14 fractures, nine were recorded for ETTs without maintenance (OR=1.17). The ETTs of patients with bruxism who had not had any maintenance had 1.59 more chances of presenting fractures (Relative risk 1.59 IC 95% 1.05 – 2.41).

Discussion

This retrospective study covering 44 years shows a 90% success rate of ETTs after a mean survival of 19 years. Regarding the long observation period, the results can be considered excellent when compared to other clinical international studies (Table 5). Only one study presented results after 15 years with a success rate of 55% (9) and three studies over about ten years reported success rates of 83% (59) to 94% (11,13).

AUTHOR	CAST POSTS (n)	SUCCESS (%)	PERIOD (y)
Salvi et al (5)	86	97	4 to 6
Bergman et al (7)	96	91	6
Creugers et al (8)	127	94.5	5
Hikasa et al (9)	187	55.4	15
Torbjörner et al (10)	456	85	4 to 5
Weine et al (11)	138	93.5	>10
Jung et al (12)	41	90	5 to 10
Ellner et al (13)	40	94	10
Gómez-Polo et al (59)	54	83	>10

Table 5: Clinical studies of cast posts and cores (n=number; y=years).

When considering occlusal forces, sex could be a variable related to the integrity of the re-

habilitated ETT. Indeed, the maximum occlusal force developed by women has been reported to be 597 N, significantly lower than that of men, which reached 847 N. Fifty-five percent of this force is exerted at second molar level, with a 20% reduction in the incisors. However, in men with parafunctional habits, the force may go from 911 N at the molars to 597 N in the incisors (18).

Only a few studies have examined age, sex, bruxism and frequency of the maintenance therapy (9, 12, 19, 20). Statistical analysis in this study showed that age, sex, bruxism and maintenance, with different association values, were related to the survival of ETTs rehabilitated with a cast post and a crown restoration.

In a cross-sectional study to determine the prevalence of TMD and bruxism in Uruguay, the prevalence of active bruxism was reported to be 31%. Female prevalence was strongly predominant (21). Comparable results in epidemiological studies of TMD have been presented elsewhere (22).

In this study the prevalence of active bruxism was 27%, thus in relative accordance with the papers mentioned above. According to the data previously presented, 69 of the 95 patients (73%) in the observed period have or had a history of parafunction.

Heavy forces caused by parafunction may be a risk factor for the integrity of the ETTs rehabilitated with a cast post and a crown restoration. In fact, 12 of the 14 fractures occurred in patients diagnosed with bruxism. Five teeth fractures occurred in maxillary premolars and 5 in maxillary anterior teeth, which can suggest that the type of tooth, the location in the dental arch and parafunctional non-axial strong forces might be risk factors for tooth fracture.

The use of posts has decreased in recent years. In many ETTs with large coronal remnants, it is possible to make restorations using adhesive procedures, without the need for root anchorage (23). There are laboratory (24-30) and clinical studies (31, 32) supporting this. Some clinical studies into ETTs with large coronal remnant, restored with or without post and a single crown, showed similar clinical results (5, 8, 40, 41). Therefore, coronal remnants and type of restoration could be more important than the post. However, further longer-running clinical studies are needed.

Furthermore, laboratory studies have shown that the best protection against fractures is the presence of 2 mm or more of coronal dentin, which allows for the ferrule or clamp effect (33). A uniform coronal remnant of 2 mm in height is more important than the length of the post (34, 35) and more important than the length of the post and the type of cement used (36). When the coronal remnant is not uniform, the location and the volume of the remnant affect the resistance to fracture (37, 38). The possibility of covering the coronal remnant with the cast post increases its resistance to fracture by 30% (39).

Five clinical prospective studies (8, 13, 40-42), three retrospectives studies (9, 12, 43) and a review (44) concluded that the coronal remnant was the most highly predictable factor in the longitudinal success of ETTs. This very important variable cannot be assessed scientifically in this work because the presence and location of the coronal remnant for each case was not recorded. However, the good clinical outcome may be attributed to the existence of a single operator (45) who followed the above recommendations, aiming at preserving the dental structure as much as possible.

In laboratory studies, the adhesive resistance of fiber posts was equivalent to gold posts, whether adhesively or conventionally cemented (36, 46). Cast posts had higher retention values when cemented with zinc phosphate cement than with resin cements (47, 48).

Donovan and Cho (49) consider zinc phosphate cement the cement of choice for cast posts, gold and metal ceramic restorations. In the present study, zinc phosphate cement was used, and only one post loosened, which would support these authors' view.

Several clinical studies have shown that loosening of cast posts and tooth fractures were the most frequent reasons for failures (7-11), while caries and periodontitis were less prevalent (9, 12). About half the failures (48%) in this study were root fractures, whereas loosening and caries were rare causes of failure.

The fractures could be related to the position in the dental arches, presence and location of the coronal remnant, thickness of the root walls, parafunctional forces, the high elasticity module of the post and the absence of a periodical functional occlusal control. Furthermore, the loss of pulp tissue reduces proprioception, increasing the risk of overloads and fractures (50-52).

On the other hand, some researchers consider occlusal design to be more important than the kind of post (19, 20).

Laboratory studies showed that in endodontically treated premolars with MOD cavities, bonded ceramic inlays did not reinforce the remnant dental structures (28, 53) while endodontically treated premolars with MOD cavities increased their resistance to fracture with bonded cast onlays (25, 29).

The design of tooth preparation and the type of restoration could influence clinical success. Of the successful ETTs, 181 had a full crown restoration which fully embraced the dental structure. Eighty-two posterior partial restorations were gold onlays and 5 bonded ceramic onlays, which mainly transmit compressive forces to the teeth (27). Furthermore, according to some studies (54-57), the good quality evaluation of these restorations could have influenced the good result of endodontic treatment and therefore the success of the restored ETTs.

Considering the kind of restoration, the survival rate was 91% for single teeth and 84% for abutments of FDPs, indicating a higher risk of failure for ETTs as abutments in FDPs. This agrees with the meta-analysis in a systematic review by Ploumaki et al (58) showing 92% success rate for single crowns and 79% for FDPs.

Therefore, according to the results of this research, a long survival of ETT restored with cast post and core in gold or noble alloy and a crown restoration can be expected, but several factors must be considered to reach a good level of clinical success.

Conclusions

In this retrospective study covering 44 years, the clinical success of ETTs rehabilitated with cast posts and cores in gold or noble alloy and a crown restoration was high: 90% for a mean survival time of 19 years. The failure rate was 10%. Tooth fracture was the most prevalent reason for failure (5% of all restored teeth and half of the failures), whereas cases of caries and loosening were rare.

This research also showed that the clinical success of cast posts and cores, in gold or noble alloy, was related to different factors, and that the clinician must bear in mind the several variables that could statistically influence these results.

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