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1 **LONG TERM OUTCOMES OF FULL PULPOTOMY IN PERMANENT MOLARS**
2 **FOR PATIENTS REQUIRING ENDODONTIC TREATMENT TREATED IN A**
3 **SINGLE, SHORT SESSION: ~~A RETROSPECTIVE STUDY~~ UNDER SPECIAL**
4 **CONDITIONS**

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22 **DECLARATIONS OF INTEREST:** The authors deny any conflicts of interest related to this
23 study.

1 **ABSTRACT**

2 **OBJECTIVES:** Endodontic procedures for patients requiring treatment in a single, short
3 session need to be validated. This study aimed at evaluating the long-term outcome of full
4 pulpotomy in permanent molars performed with reinforced zinc oxide-eugenol cement
5 (Intermediate Restorative Material (IRM®)), immediately restored using stainless steel
6 crowns under general anaesthesia (GA).

7 **MATERIALS AND METHODS:** The absence of clinical signs and symptoms and the
8 evolution of the Peri-Apical Index between the treatment date (T0) and the longest follow-up
9 time (T1) were used to grade pulpotomy outcome as “effective”, “uncertain” or “ineffective”.
10 Impact of different criteria on pulpotomy outcome was tested (aetiology of lesion, tooth
11 maturity, endodontic difficulty related to coronal shape and root canal shape, and endodontic
12 difficulty related to radiographic root canal appearance).

13 **RESULTS:** Among the 608 teeth (338 patients), treated in a single session with IRM® full
14 pulpotomy and stainless steel preformed crowns, 263 (143 patients) were evaluated after a
15 median follow-up period of 24 months. Overall, 89% of pulpotomies were effective, 7.6%
16 were of uncertain outcome and 3.4% were ineffective. No tested criteria influenced the rate of
17 effectiveness.

18 **CONCLUSIONS:** Long-term outcomes of IRM® pulpotomy are similar to those of calcium
19 silicate based-cement pulpotomy observed in the literature. This procedure should not be
20 restricted to patients treated under GA however, as it is relevant for all special conditions that
21 impose the provision of endodontic treatment in a single, short session, such as dental care
22 emergencies during humanitarian crises or pandemic periods.

23 **KEYWORDS**

24 Full pulpotomy; Permanent molar; General anaesthesia; Preformed crowns; Follow-up study;

25 Single session

26 INTRODUCTION

27 For the purposes of this article, ‘special conditions’ is a term characterizing a medical, social
28 or environmental context that imposes restrictions on the provision of conventional dental
29 treatment. These restrictions may include limited intervention time, need for rehabilitation in
30 a single, short session, particular ergonomic conditions, difficulty in reaching a precise
31 diagnosis, availability of low cost materials only, and need for easily handled materials. Such
32 special conditions are encountered during pandemic periods due to the need to limit high-risk
33 contamination by saliva, blood, mucosal secretions and physical contact; during dental care
34 under general anaesthesia (GA); and during humanitarian dental interventions. Reversible and
35 irreversible pulpitis due to deep carious lesions or injury are the most common complaint
36 reported in these situations (1). In order to avoid extractions, endodontic procedures should be
37 adapted to the context of the special conditions, whilst aiming to obtain the same outcome as
38 conventional academic procedures, i.e. maintenance of an asymptomatic and functional tooth
39 in the mouth (2).

40 In past years, convergent results from the literature suggest that permanent vital teeth with
41 pulpitis (3) may be treated using full pulpotomy. A ~~recent~~ systematic review reported a
42 clinical success rate of pulpotomy performed on permanent teeth with irreversible pulpitis of
43 93.97%, and a radiological success rate of 88.39% after 36 months follow-up (3). Several
44 studies have shown similar success rates for full pulpotomy compared to root canal treatment
45 (RCT) (3,4). It might be expected that full pulpotomy will become the endodontic treatment
46 of choice for affected teeth with a vital pulp, instead of RCT. This may be particularly true for
47 difficult endodontic cases (5) and when treatment is undertaken in special conditions limiting
48 the operatory time and subsequent intervention. Patients consulting dental services during
49 pandemic periods, those treated under GA, and those treated during humanitarian crises share
50 the same special conditions for treating vital teeth with deep carious lesions.

51 Performing endodontic under special conditions is a challenge as RCT is time-consuming and
52 requires advanced technology (6). These conditions are neglected in the international
53 guidelines. Local protocols established in these contexts indicate extraction, abstinence and/or
54 prescription instead of endodontic treatment. Consequently, being treated under special
55 conditions implies degraded treatment outcomes with extractions being preferred to
56 ~~minimally-invasive~~ endodontics. Ethical issues impose however that patients receive equitable
57 quality of care, and equitable treatment outcomes, whether treated conventionally or under
58 certain constraints (7). In this context, it is legitimate to investigate whether full pulpotomy
59 can be indicated instead of RCT. Answering this question implies reviewing the literature to
60 define which procedures and materials could be used for full pulpotomy and coronal
61 restoration in a single session, and then verifying the outcomes of these adapted procedures by
62 clinical trial. Data from dental treatment under GA might be considered as a reference for full
63 pulpotomy under special conditions, potentially offering an opportunity to evaluate this
64 conservative solution for treating patients during pandemic periods or humanitarian crises.

65 Literature reviews on materials for full pulpotomy report radicular pulp capping with Calcium
66 Hydroxide (CaOH₂), CaOH₂ covered with Zinc Oxide Eugenol cement (ZOE) or reinforced
67 zinc oxide-eugenol cement IRM® (Intermediate Restorative Material), ZOE, Calcium-
68 Enriched Mixture (CEM), Mineral Trioxide Aggregate (MTA) or Biodentine™ (8,9). It has
69 previously been suggested that the removal of the most inflamed part of the pulp followed by
70 cavity sealing to avoid reinfection, is a reliable means to obtain pulp sedation (10). Overall,
71 there is agreement that calcium silicate cements, such as MTA, CEM and Biodentine™, are
72 pulpal regenerative materials that can result in both pulp healing and clinical success.
73 However, positive clinical results have also been reported with CaOH₂ (11) or CaOH₂
74 covered with ZOE (12) or IRM® (13), despite the lack of regular tertiary dentinogenesis
75 induction. Thus procedural arguments, instead of biological ones, may be considered when

76 proposing materials for radicular pulp capping under special conditions. The chosen pulp
77 capping material should be easy to handle, have a fast setting time and be compatible with
78 immediate coronal restoration. The setting time of MTA is long, over two hours, leading to a
79 delay in the permanent restoration and increasing the risk of immediate post-operative
80 contamination. Of the ~~these~~ materials reported for pulpotomy in permanent teeth, only
81 Biodentine™ and IRM® allow the tooth to be restored immediately. The setting times of
82 Biodentine®, MTA Angelus® or MM-MTA® are much longer than that of IRM® and their
83 costs are much higher. All these considerations tend to indicate IRM® as an appropriate pulp
84 capping material for full pulpotomy performed under special conditions. However, IRM® is
85 not currently considered to be a pulp capping material except for deciduous teeth (14) and
86 there is a need to assess the long-term outcome of pulpotomies undertaken using this material.

87 The decision to use stainless steel crowns for the coronal restoration of teeth with deep
88 carious lesions following pulpotomy under GA was also based on previous studies. Survival
89 rates of teeth with carious cavities on more than three surfaces have been shown to be higher
90 when restored with full or partial crowns rather than with composite restorations (15). Teeth
91 being restored with composite (16,17) had worse fracture resistance and marginal integrity,
92 increased cervical marginal micro-leakage, more surface roughness, postoperative sensitivity
93 and soft-tissue irritation than those restored with indirect full or partial crowns. Indirect
94 restoration is not feasible under special conditions, direct bonded restorations are time
95 consuming and incompatible with IRM, amalgam restorations are generally to be avoided for
96 ecological reasons. The use of pulpotomy with IRM® followed by the immediate placement
97 of a stainless steel crown could thus be a conceivable alternative procedure for the treatment
98 of vital teeth under special conditions (18,19).

99 This study aims to assess the long-term outcome of pulpotomies performed with IRM® on
100 permanent molars and immediately restored using stainless steel crowns under GA.

101

102 **MATERIALS AND METHODS**

103 **Type of study**

104 This retrospective study was approved by the local ethical committee (CE-CIC-GREN-5044-
105 11/17) and was performed in accordance with the ethical standards as laid down in the 1964
106 Declaration of Helsinki and its later amendments.

107 **Data collection**

108 The study population consisted of all patients from the special care unit of the Dental
109 University Hospital of Clermont-Ferrand, treated under GA between November 2008 and July
110 2017. Local protocols impose a conservative full-mouth rehabilitation approach with as few
111 extractions as possible. Indications included patients presenting anxiety disorders and high
112 levels of carious disease, medically-compromised patients, patients with disability (physical,
113 cognitive or mental) and patients presenting with a severe gag reflex. For all patients, a full
114 record is kept of the dental status and diagnoses at the start of the intervention, and of the
115 treatment provided during that session. Patients were excluded if the treatment did not include
116 at least one permanent molar treated by full pulpotomy and stainless steel crown placement.
117 The beginning of the follow-up period (T0) was defined as the date at which the pulpotomy
118 was performed under GA. The immediate post-operative radiograph was collected.

119 After GA, patients are routinely scheduled for a one-month post-operative appointment. They
120 are then free to come back to the hospital for regular annual check-ups ~~if they wish~~. Clinical
121 and radiographic evaluations were undertaken at each check-up appointment. Regular check-
122 ups were undertaken in the dental surgery with or without conscious sedation, or under
123 subsequent GA depending on the level of patient cooperation. No systematic recall of patients
124 was carried out, except for the one-month post-operative appointment. For each patient, the

125 radiological and clinical data recorded at the longest follow-up period (T1) were retained to
126 assess pulpotomy outcome.

127 **Pulpal status**

128 Performing all diagnostic tests pre-operatively was not systematically possible due to medical,
129 physical, cognitive or mental conditions of the patients. Pulpal status was evaluated during the
130 intervention under GA, and the tooth was categorized as either vital or non-vital according to
131 clinical and radiological criteria. During the clinical examination, the absence of a sinus tract
132 or swelling were verified. Radiographically, peri-apical health was determined on retro-
133 alveolar radiography using the Peri-Apical Index (PAI), described by Orstavik et al. in 1986
134 (20). Pulpotomies were performed on teeth with a PAI of 1, 2 or 3. Pulp vitality was
135 confirmed per-operatively by presence of bleeding in the pulp chamber and from the canal
136 orifices. Conventional root canal treatment was performed for non-vital teeth and these were
137 not included in the study.

138 **Procedure for pulpotomy**

139 After rubber dam placement, carious tissue was removed under irrigation with a round
140 tungsten carbide bur in a slow-speed hand-piece. Once the pulp chamber was opened,
141 constant irrigation with 2.5% hypochloride solution was used for each further step. Shaping of
142 the access cavity was undertaken with a Zekrya bur in a high-speed hand-piece. Preparation of
143 the canal orifices was undertaken with a no. 3 or 4-sized Gates Glidden bur in a slow-speed
144 hand-piece. Bleeding had to stop within 6 minutes. After final hypochloride irrigation and
145 drying, pulp capping was performed by placing zinc oxide-eugenol cement (IRM®) into the
146 access cavity and all canal orifices. The definitive restoration was undertaken immediately
147 after the pulpotomy procedure, using stainless steel preformed crowns sealed with glass
148 ionomer cement (GIC).

149 **Outcome evaluation criteria**

150 Outcome evaluation included a combination of clinical and radiographic examination (Table
151 1) (21). Radiographically, the evolution of PAI (20) was assessed between T0 (post-operative
152 radiograph taken immediately following treatment) and T1 (radiograph taken during the latest
153 check-up appointment). For a tooth with multiple root canals, the root with the highest PAI is
154 taken into account. For immature teeth, further physiological root growth was verified
155 between T0 and T1.

156 Clinical assessment was undertaken by the patient's usual practitioner at a regular check-up
157 appointment. Data regarding presence of pain, sinus tract, or swelling were recorded in the
158 patient's medical file. Due to the ethical frame of this observational study, it was not possible
159 to blind the assessors to the collection of clinical data. However, blind assessment was
160 respected for radiological assessments. PAI scores at T0 and T1 were assessed using the
161 immediate postoperative and long-term follow-up radiographs. The calibrated investigators
162 scored the PAI for each tooth independently. Preoperative radiographs were not considered
163 for outcome assessment in order to blind assessors between T0 and T1 images.

164 For the evaluation of radiological criteria, all radiographs collected at T0 and T1 were
165 proposed in a random order to be interpreted by two calibrated investigators. If there was a
166 disagreement, a consensual decision was made between both readers and a third calibrated
167 investigator. For calibration, both investigators were trained to interpret PAI scores with a test
168 and retest 15 days apart on 100 X-rays illustrating the five score categories. The intra-class
169 correlation coefficient (ICC) for inter-rater assessment was 0.95 ($p < 0.001$) for the test phase
170 and 0.93 ($p < 0.001$) for the retest at 15 days. Intra-rater validity was 0.87 ($p < 0.001$) for the
171 first expert and 0.90 ($p < 0.001$) for the second expert. The first examiner's reliability was 0.87
172 ($p < 0.001$) relative to the expert panel on the test and 0.89 ($p < 0.001$) on the retest at 15 days

173 and for the second examiner, the reliability relative to the expert panel was 0.86 ($p < 0.001$) on
174 the test and 0.88 ($p < 0.001$) on the retest.

175

176 **Factors potentially affecting treatment outcomes**

177 *Aetiology*

178 The dental pathology or indication for endodontic treatment were grouped into four
179 categories: carious disease, molar-incisor hypomineralisation, bruxism, and endodontic
180 treatment in preparation of prosthetic rehabilitation.

181 *Tooth maturity*

182 Teeth were dichotomized into two categories with regards apical growth (mature/immature
183 teeth) (22).

184 *Potential difficulty of endodontic treatment*

185 Evaluation of the potential difficulty of RCT was performed using the American Association
186 of Endodontists form (23,24). Only three criteria were applicable for pulpotomies: coronal
187 shape, root canal shape, and root canal radiographic appearance.

188

189 **Statistical analysis**

190 Descriptive analysis was performed using Excel and the statistics were undertaken using IBM
191 SPSS Statistics version 25 (Statistical Package for the Social Sciences). Student's t-tests were
192 used to compare the whole group to the follow-up group with respect to age, average duration
193 of the intervention under GA, and average number of teeth treated under GA. Pearson chi-
194 squared tests were used to compare the whole group to the follow-up group with regards sex,
195 patient typology, data on the type of treated teeth and also to analyse the impact of aetiology,
196 tooth maturity and endodontic difficulty criteria on pulpotomy outcomes.

197

198 **RESULTS**

199 **Participants**

200 The distribution of included teeth (patients) is presented in Figure 1. The whole study group
201 consisted of 338 patients (age range: 7-93 years old; of which 96 were <16 years-old)
202 presenting 608 permanent molars treated with ~~full~~ IRM® pulpotomy and immediately
203 restored with stainless steel crowns.

204 The follow-up group consisted of 143 patients (age range: 9-64 years old; of which 21 were
205 <16 years-old), presenting 263 treated teeth, who attended a follow-up check-up during which
206 a complete clinical and radiological examination could be performed. The patient follow-up
207 rate was 42.3%. The average follow-up time was 29.9 ± 26.6 months (min = 1, max = 88).
208 The median follow-up time was 24 months. Comparisons between whole and follow-up
209 groups are reported in Table 2 in terms of patients and in Table 3 in terms of teeth.

210 **Follow-up evaluation**

211 Of the 263 evaluated treatments, 234 (89%) were effective, 20 (7.6%) were ~~of~~ uncertain
212 ~~outcome~~ and 9 (3.4%) were ineffective. The rate of effectiveness was 91.7% within 24
213 months and 86.2% after a follow up period of over 24 months. The distribution of the
214 treatments' outcome is presented in Table 4. Of the factors tested, no criteria statistically
215 influenced the outcome (Pearson Chi square test, NS).

216

217 **DISCUSSION**

218 Treating vital teeth using IRM® full pulpotomy and stainless steel crown placement in a
219 single session is effective in the long term. This study was conducted in patients treated under

220 GA, but its findings concern other special conditions in which patients require treatment in a
221 single, short session. ~~In such special conditions,~~ This procedure allows vital teeth to be
222 managed with a long-term goal, avoiding both extraction and the need for a second
223 appointment. Time constraints and one-off service access are special conditions that often
224 exclude conventional endodontic procedures, particularly if several teeth need to be treated.
225 Pulpotomy and immediate stainless steel crown placement in vital permanent teeth are
226 adapted procedures that should be considered as validated alternatives to conventional
227 “academic” procedures in such conditions. This study demonstrated that these alternative
228 procedures attain the outcomes of academic treatments i.e. maintenance of an asymptomatic
229 and functional tooth in the mouth. Moreover, the opportunity remains to replace stainless steel
230 crowns with conventional crowns at a later stage, when the causes determining the special
231 conditions relent. In terms of public health, this implies that there is no loss of equity in
232 treatment outcomes as patients retain all the benefits of preserving their teeth.

233 Beside the public health implications, it is of interest to discuss the results of this study in
234 light of previous studies on full pulpotomy. Based on clinical and radiological criteria, this
235 study reports unexpectedly positive results from full pulpotomy with IRM®. A previous study
236 reported strong evidence for the use of MTA, CEM or Biodentine™ for pulp capping (21).
237 Differences between criteria used to evaluate the success of pulpotomy could explain this
238 situation. Some authors focus on the biological effect of the pulpotomy material on the pulp
239 and evaluate the development of a dentinal bridge as a criterion of success (25–27). However,
240 the radiological evaluation of the development of a dentinal bridge is not reliable and even if
241 it is detected, neither the quality of the bridge nor the pulpal status under the bridge can be
242 tested (21). Moreover, a dentinal bridge is not always created under calcium silicate based-
243 cements, such as MTA and Biodentine™ (28). Such criteria assess the biological impact of
244 the material on pulpal tissues, considered as a sign for biocompatibility of material, rather

245 than the effectiveness of the pulpotomy. Other authors consider preservation of a functional
246 tooth as a successful outcome (21). In this case, as for conventional RCT, evaluation criteria
247 combine both a clinical and a radiological examination. The state of the radicular pulp cannot
248 be objectively assessed. Indeed, vitality tests do not faithfully reflect the histological state of
249 pulpal tissues (29–31). Moreover, pulp vitality tests are not reliable once a material has been
250 placed over the pulp canal orifices and it may be difficult to evaluate pulp vitality (21). In the
251 absence of bacterial contamination, asymptomatic irreversible pulpitis and necrobiosis would
252 not evolve toward further disease (32). The efficiency of pulpotomy is thus assessed clinically
253 and radiographically with the evaluation of the absence of signs of failure. Clinically, failure
254 is expressed by signs and symptoms of acute disease (spontaneous pain, pain on percussion,
255 pain on apical palpation, swelling) or chronic disease (sinus tract). Radiologically, failure is
256 expressed by the development of a periapical lesion, or with an increase in size of a pre-
257 existing periapical lesion. In this study, no apical disease was recorded for 89% of cases and
258 radiological uncertainty was recorded for 7.6%. The absence of evolution of a pre-existing
259 periapical lesion suggests that the treatment outcome is uncertain and needs further follow-up
260 (24) (21).

261 The composition of the pulp capping material is not the main factor for the successful
262 outcome of pulpotomy. The key concept for effective pulpotomy is the prevention of bacterial
263 infection (21). During the current study, initial vital pulp status was verified by the absence of
264 clinical and radiological signs of infection and by the presence of bleeding in the pulp
265 chamber and all canal orifices. Aseptic conditions were maintained during all pulpotomy
266 procedures as rubber dam was systematically placed before removal of carious tissue and
267 disinfection was ensured using sodium hypochlorite irrigation. Placement of IRM® as a pulp
268 capping material allowed immediate seal of the radicular pulp segments. Finally, an
269 immediate hermetic coronal restoration was guaranteed by the placement of stainless steel

270 crowns, providing long-term sealing of the pulpotomy. The combination of all these elements,
271 and particularly the immediate hermetic coronal restoration (8,27,28,33–35), are probably the
272 factors that best explain the high level of effectiveness for pulpotomy reported here. The
273 peripheral seal achieved with ~~glass ionomer cement~~ (GIC) and stainless steel crowns is
274 efficient enough to avoid postoperative contamination, GIC dissolution being limited under
275 the crown. It has been reported that the survival of posterior permanent teeth restored with
276 stainless steel crowns is 79.2% after 10 years and this therefore represents a viable treatment
277 choice for severely carious or fractured posterior permanent teeth (18). However, serious
278 concerns are raised regarding the ability of preformed stainless steel crowns to satisfy the
279 same specifications as those required from a conventional crown. The quality of the cervical
280 margin of the coronal restoration could affect the long-term outcome of pulpal therapy.
281 Indeed, high adaptation of the cervical limits might induce coronal contamination and
282 radicular contamination is a risk if the margin is too low. Additional studies are needed to
283 determine the tooth survival rate and the degree of periodontal morbidity induced by
284 preformed crowns.

285 **CONCLUSION**

286 The treatment of vital teeth under special conditions should be cause for reflection in
287 endodontic communities. Full pulpotomy with IRM® followed by immediate placement of a
288 stainless steel crown cemented with GIC is a validated alternative procedure to conventional
289 RCT and offers a satisfactory treatment outcome when performed under GA. This procedure
290 should not be restricted to patients treated under GA however, as it is relevant for all special
291 conditions that impose the provision of endodontic treatment in a single, short session, such as
292 dental care emergencies during humanitarian crises or pandemic periods.

293

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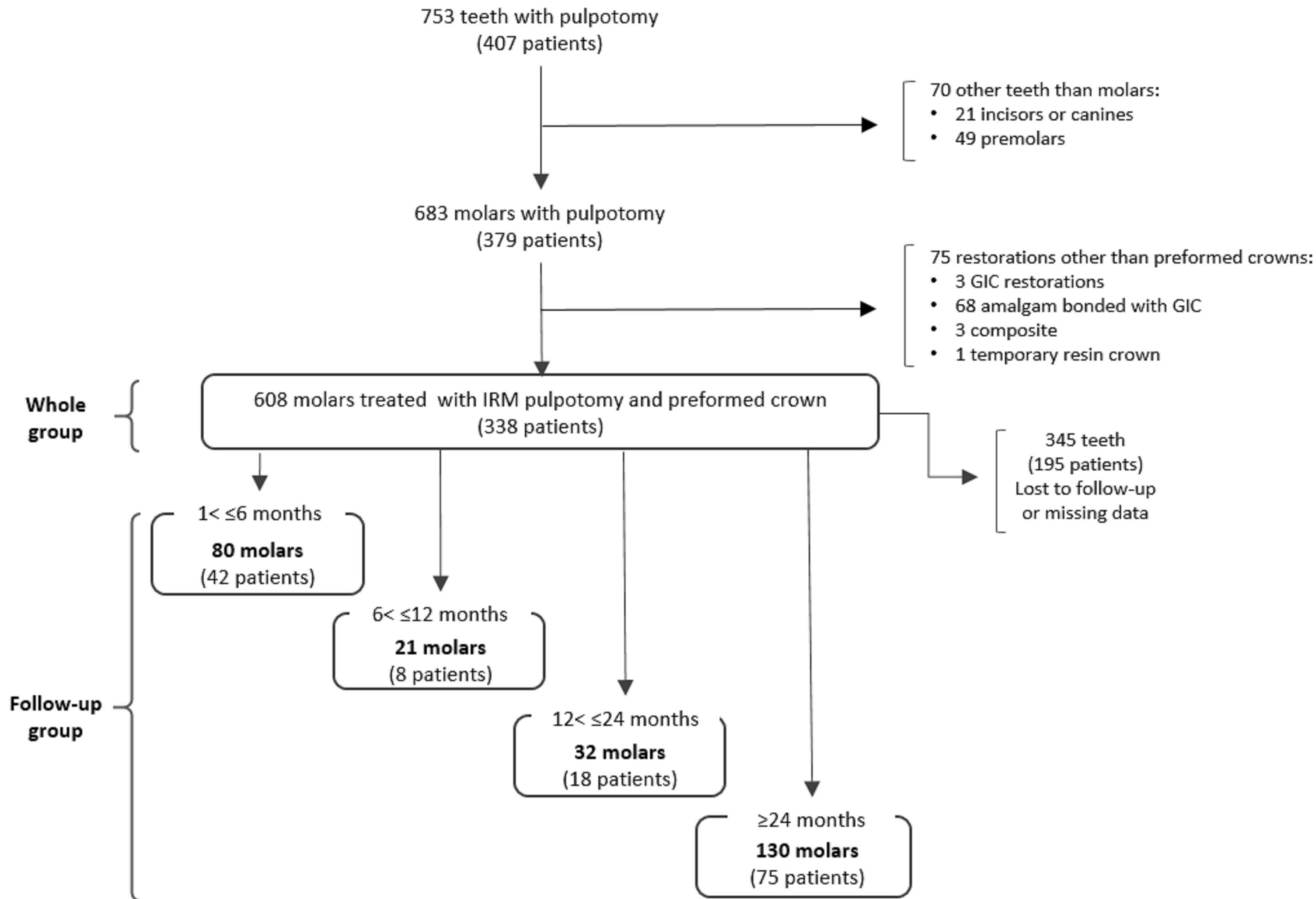
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401 **FIGURE CAPTIONS**

402 **Figure 1:** Distribution of included teeth (patients) over the duration of follow-up for the
403 whole cohort.

404

405



1 Table 1: Clinical and radiological criteria used to assess pulpotomy outcome (21). (The condition for
 2 ineffective pulpotomy with PAI (T0) ≥ 3 and PAI (T1) > 3 could be checked only for teeth with PAI
 3 (T0) =3, as PAI (T0) >3 were not included in the cohort).

	Clinical examination	Radiographic evolution
Effective pulpotomy	Absence of signs and symptoms after pulpotomy	<ul style="list-style-type: none"> - PAI (T0) and PAI (T1) = 1 - or PAI (T0) = 2 and PAI (T1) ≤ 2 - or PAI (T0) ≥ 3 and PAI (T1) ≤ 2 - and lack of radicular lacunae - for immature teeth: further physiological root growth
Uncertain pulpotomy	Absence of signs and symptoms after pulpotomy	<ul style="list-style-type: none"> - PAI (T0) = 1 and PAI (T1) = 2 - or PAI (T0) and PAI (T1) = 3 - and lack of radicular lacunae
Ineffective pulpotomy	Presence of signs and symptoms after pulpotomy	<ul style="list-style-type: none"> - PAI (T0) = 1 or 2 and PAI (T1) ≥ 3 - or PAI (T0) ≥ 3 and PAI (T1) > 3 - and/or presence of radicular lacunae - for immature teeth: no further physiological root growth

4

1 **Table 2:** Comparison between the whole group and the follow-up group in term of patient data.

	Whole group of patients (n=338)	Follow-up group of patients (n=143)	
Sex (% (n))			Pearson Chi Square Test
Men	52.7% (178)	53.1% (76)	ns
Women	47.3% (160)	46.9% (67)	
Age (years) mean \pm SD	27.1 \pm 14.5	29.9 \pm 12.7	Student's t-test, p<0.05
Patient typology (% (n))			Pearson Chi Square Test, ns
Anxiety disorder / multiple caries	55% (186)	58.7% (84)	ns
Medically compromised	21.6% (73)	21.0% (30)	ns
Disability	20.1% (68)	19.6% (28)	ns
Gag reflex	1.2% (4)	0	ns
<i>Missing data</i>	2.1% (7)	0,7% (1)	
Duration of GA intervention mean \pm ET (minutes)	109.7 \pm 33.1	121.0 \pm 31.3	Student's t-test, p<0.05
<i>Missing data (n)</i>	10	4	
Number of teeth treated mean \pm SD	12.9 \pm 4.8	13.4 \pm 4.8	Student's t-test ns

SD: standard deviation; ns: non significant

2

3

1 **Table 3:** Comparison of the teeth of the whole group and the follow-up group in terms of criteria for the
 2 difficulty of endodontic treatment (American Association of Endodontists, 2006) (21).

	Whole group No. of teeth (n=608) % (n)	Follow-up group No. of teeth (n=263) % (n)	Pearson Chi Square Test
Aetiology			ns
Carious lesion	92.8% (564)	91.6% (241)	
Molar-Incisor Hypomineralisation	0.7% (4)	0	
Bruxism	0.7% (4)	0.8% (2)	
Preparation for prosthetic rehabilitation	0.1% (1)	0	
<i>Missing data</i>	5.7% (35)	7.6% (20)	
Tooth maturity			ns
Mature teeth	88% (535)	90.5% (238)	
Immature teeth	12% (73)	9.5% (25)	
<i>Missing data</i>	0	0	
Difficulty related to coronal shape			ns
Minimal	8.6% (52)	10.3% (27)	
Moderate	68.3% (415)	84% (221)	
High	0	0	
<i>Missing data</i>	23.1% (141)	5.7% (15)	
Difficulty related to root canal shape			ns
Minimal	31.6% (192)	45.2% (119)	
Moderate	33% (201)	39.2% (103)	
High	11.7% (71)	9.9% (26)	
<i>Missing data</i>	23.7% (144)	5.7% (15)	
Difficulty related to radiological appearance of root canal			ns
Minimal	36% (219)	37.3% (98)	
Moderate	30.3% (184)	38.8% (102)	
High	10.7% (65)	18.6% (49)	
<i>Missing data</i>	23% (140)	5.3% (14)	

ns: non significant

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4

1 **Table 4:** Outcome of pulpotomy performed on permanent molars immediately restored with stainless
 2 steel crowns according to the follow up period in months (n = 263).

	<i>Follow up evaluation (t = time in months)</i>				Total
	t ≤ 6	6 < t ≤ 12	12 < t ≤ 24	24 < t	
	% (n)				
Effective pulpotomy	32% (75)	7.7% (18)	12.4% (29)	47.9% (112)	89% (234)
Uncertain pulpotomy	25% (5)	5% (1)	10% (2)	60% (12)	7.6% (20)
Ineffective pulpotomy	0	22.2% (2)	11.1% (1)	66.7% (6)	3.4% (9)
Total per follow-up period	30.4% (80)	8% (21)	12.2% (32)	49.4% (130)	100% (263)

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