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Efficacy of conventional treatment with composite resin and atraumatic restorative treatment in posterior primary teeth: study protocol for a randomized controlled trial

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3 1 Efficacy of conventional treatment with composite resin and atraumatic
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5 2 restorative treatment in posterior primary teeth: study protocol for a
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7 3 randomized controlled trial
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1
2
3 51 **Abstract**
4

5 52 **Introduction:** Despite the widespread acceptance of conventional treatment using
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7 53 composite resin in primary teeth, there is no evidence that this approach is the best
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10 54 option in pediatric clinics. Atraumatic restorative treatment (ART) using high-
11
12 55 viscosity glass ionomer cement (GIC) has gradually become more popular because it
13
14 56 performs well in clinical studies, is easy to handle and is patient friendly. Therefore,
15
16 57 the aim of this randomized clinical trial study is to compare the efficacy of
17
18 58 conventional treatment using composite resin with that of ART in posterior primary
19
20 59 teeth. As secondary outcomes, cost-efficacy and patient self-reported discomfort will
21
22 60 also be tested.
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24
25 61 **Methods and analysis:** Children aged 3 to 6 years presenting with at least one
26
27 62 occlusal and/or occlusal-proximal cavity will be randomly assigned to one of two
28
29 63 groups according to the dental treatment: ART (experimental group) or composite
30
31 64 resin restoration (control group). The dental treatment will be performed at a dental
32
33 65 care trailer located in an Educational Complex in Barueri/SP, Brazil. The unit of
34
35 66 randomization will be the child. A sample size of 240 teeth with occlusal cavities and
36
37 67 188 teeth with occlusal-proximal cavities has been calculated. The primary outcome
38
39 68 will be restoration longevity, which will be clinical assessed after 6, 12, 18 and 24
40
41 69 months by two examiners. The duration of the dental treatment and the cost of all
42
43 70 materials used will be considered when estimating the cost-efficacy of each treatment.
44
45 71 Individual discomfort will be measured after each dental procedure using the Facial
46
47 72 Scale of Wong-Baker.
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51
52 73 **Ethics and dissemination:** This clinical trial was approved by the Local Ethics
53
54 74 Committee from the Faculty of Dentistry of the University of Sao Paulo (registration
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2
3 75 #1.556.018). Participants will be included after their legal guardians have signed an
4
5 76 informed consent form containing detailed information about the research.
6

7 77 **Trial registration:** www.clinicaltrials.gov, NCT02562456. Registered on September
8
9 78 25th 2015.
10

11 79 **Keywords:** restorative dental treatment, primary teeth, composite resin, glass
12
13 80 ionomer cement, atraumatic restorative treatment, randomized clinical trial, cost-
14
15 81 efficacy analysis
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20 83 **Strengths and limitations of this study**

- 21 84 • Considering that the success of a restorative treatment is intrinsically related to
22
23 85 the handling of the material, it seems necessary to study these techniques
24
25 86 under controlled conditions to extract from them the best clinical performance
26
27 87 they can offer;
28
29 88 • An efficacy study can maximize the likelihood of observing an intervention
30
31 89 effect by investigating the benefits and harms of it under highly controlled
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33 90 conditions;
34
35 91 • This is the first clinical trial comparing the longevity, cost-efficacy and self-
36
37 92 reported discomfort assessment between conventional restoration using
38
39 93 composite resin and ART with high-viscosity GIC in posterior primary teeth;
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41 94 • Blinding of operators and patients will not be possible because of the evident
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43 95 differences between the techniques.
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100 Introduction

101 Restorative care in primary teeth is part of the comprehensive oral health treatment of
102 children and adolescents,[1] which should guarantee appropriate functional and
103 aesthetic conditions until tooth exfoliation.[2] There is an ongoing search for ideal
104 restorative materials for use in pediatric dentistry,[1] but a lack of evidence
105 persists.[3, 4, 5]

106 Conventional treatment using composite resin is still one of the most common
107 approaches used in pediatric dental clinics.[6] Despite the aesthetic quality,
108 preservation of dental structure, and abrasion wear rate similar to that of natural
109 primary teeth,[6] all composite resins suffer polymerization shrinkage, which can
110 jeopardize marginal integrity[2] and restoration longevity. Additionally, to take full
111 advantage of the properties of composite resin, absolute isolation with rubber dam is
112 necessary,[7] making the restoration not only technique-sensitive and time-
113 consuming,[2] but also more traumatic for the pediatric patient.[8]

114 An alternative to the use of composite resin is atraumatic restorative treatment
115 (ART), a minimal intervention approach that simplifies the restorative procedure
116 through the exclusive use of hand instruments, followed by the application of a
117 chemical-adhesive material.[9] ART is reported to provoke less anxiety and less pain,
118 and rarely requires local anesthesia.[10] Currently, the material of choice for ART is
119 high-viscosity glass ionomer cement (GIC),[11] which provides biocompatibility,
120 fluoride release, chemical adhesion to the tooth surface[12] and a coefficient of
121 thermal expansion similar to that of natural teeth.[4] Moreover, it is easy to use
122 because it can be placed in a single increment.[2]

123 The international scientific literature has already designated ART as an
124 appropriate procedure to treat occlusal and occlusal-proximal cavities in primary teeth

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3 125 when compared with amalgam.[4, 5] However, few clinical studies have compared
4
5 126 composite resin performance in primary teeth with any other dental material.[13, 14,
6
7 127 15] Moreover, patient-based parameters must also be assessed in order to enable a
8
9 128 more effective and appropriate choice of treatment for each individual. In this context,
10
11 129 few reports have been found in the literature regarding those outcomes such as
12
13 130 patient's acceptability[16, 17] (Novaes et al., 2012; Staman et al., 2013) and cost of
14
15 131 restorative treatments.[18,19] (Da Mata et al., 2014; Mickenautsch et al., 2009).

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18 132 Because of the need to establish the best scientific evidence about restorative
19
20 133 treatment in primary teeth, this study aims to compare the efficacy of two types of
21
22 134 treatment in primary molars (ART using high-viscosity GIC and composite resin
23
24 135 restoration) using a superiority randomized clinical trial with parallel arms.
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29 30 137 **Methods/Design**

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32 138 The present protocol follows the guidelines of the Standard Protocol Items:
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34 139 Recommendations for Interventional Trials (SPIRIT) as detailed in Attachment A.

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36 140 This clinical trial was recorded in the database for registration of clinical
37
38 141 studies (Clinicaltrials.gov registration NCT02562456). This study will be a
39
40 142 partnership with the city of Barueri, São Paulo, and it is nested to the Caries Detection
41
42 143 in Children-2 study (registration NCT02473107). Each participant will be encoded by
43
44 144 a number to guarantee information confidentiality. Any files containing identifiable
45
46 145 data will be stored in locked filing cabinets, and only researchers will have access to
47
48 146 participants' information.

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50 147 The final trial dataset will be available for inspection with the coordinator's
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52 148 endorsement. Results will be fully reported in peer-reviewed journals, the patients'
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54 149 newsletter and on the website. If participants develop any dental treatment needs after
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3 150 completion of the trial, they will be referred to the health service of the city of
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5 151 Barueri, São Paulo.

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10 153 *Sample description*

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12 154 Participants will be selected after screening in a dental care trailer located in
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14 155 the Professor Carlos Osmarinho de Lima Educational Complex (Barueri/SP). All
15
16 156 healthy children who live in the city of Barueri seeking dental treatment are potential
17
18 157 participants in our project. The trailer is set up as a regular dental office. The
19
20 158 inclusion criteria are: 1) children aged 3–6 years; 2) whose parents consent their
21
22 159 participation in the research; 3) with at least one occlusal and/or occlusal-proximal
23
24 160 cavity in a primary molar; 4) the tooth of interest should not be associated with a
25
26 161 fistula, abscess, pulp exposure, history of spontaneous dental pain or mobility; and 5)
27
28 162 the cavity of interest should allow the access by the operator using hand instruments.
29
30 163 Children who present behavior problems during the clinical examination or during
31
32 164 dental treatment will be excluded from our study.

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36 165 The child will be set as the unit of randomization, which means that all
37
38 166 eligible teeth of a child included in our research will be treated according to the same
39
40 167 treatment independently of the number of cavities. For sample calculation, data on the
41
42 168 longevity of 2 years of occlusal and occlusal-proximal composite resin
43
44 169 restorations[15] were extracted from the literature as 86% and 60%, respectively. A
45
46 170 minimum difference of 10% between treatment longevities was set as the superiority
47
48 171 limit. Taking the significance level as 5%, a power of 80% and the addition of 40%
49
50 172 owing to study design (cluster per children), the minimum number of teeth per group
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52 173 was calculated using a two-tailed test. Additionally, a sample loss of 20% was
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174 estimated, resulting in 204 teeth for the occlusal group and 240 teeth for the occlusal-
 175 proximal group (Table 1).

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Table 1 – Sample distribution.

Groups	Type of cavity	
	Occlusal	Occlusal-proximal
Control (Composite resin)	102	120
Experimental (ART)	102	120
Total	204	240

178

179 Recruitment will take place from December 2015 to June 2017. Each
 180 participant will be enrolled in the study for about 25 months: 1 month for the
 181 Randomized Clinical Trial (RCT) diagnosis and treatment, followed by a 24-month
 182 observation period. Details are illustrated in Figure 1. Participants' enrolment will be
 183 facilitated by locating the trailer inside an Educational Complex.

184 After screening, participants who have met the eligibility criteria will have
 185 their registration data collected and will be clinically examined by one operator.
 186 Radiographic examination will be performed if any doubts about the pulp
 187 involvement of the tooth of interest persist. As the child will receive complete dental
 188 treatment during the study, radiographic examination will also be used if any other
 189 treatment need demand it.

190 The same operator will also determine the dental caries experience of the child
 191 which will be assessed based on the World Health Organization (WHO) criteria that
 192 only considers evident carious cavities, and restored and/or missing teeth as a result of

1
2
3 193 carious progression.[20] Thus, the following indices will be calculated for each child:
4
5 194 def-t and DMFT; children in whom (def-t) + (DMFT) is lower than or equal to three
6
7 195 will be classified as having low dental caries experience. Children with higher scores
8
9 196 will be classified as having high dental caries experience.[21]

10
11
12 197 The randomization process will be designed in blocks of different sizes
13
14 198 generated by software. Opaque, sealed and sequentially numbered envelopes will be
15
16 199 used to randomize the participants into the treatment groups.

17
18 200 The restorative treatment will be performed by four trained and calibrated
19
20 201 operators who will disclose which treatment they are performing at the
21
22 202 commencement of the restorative procedure. However, blinding participants and
23
24 203 operators will not be possible due to the evident differences between both techniques.
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29
30 205 *Study groups*

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32 206 Participants will be randomly assigned into two different groups:

33
34 207 (a) Group I (control): composite resin restoration, using 37% phosphoric acid, Adper
35
36 208 Scotchbond Multipurpose adhesive system (3M/ESPE) and Filtek Z350 resin-
37
38 209 composite (3M/ESPE).

39
40 210 (b) Group II (experimental): ART using high-viscosity GIC Fuji IX (Gold Label – GC
41
42 211 Corp) with manual dosage and hand-mixed powder and liquid.
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47 213 *Treatment protocol*

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51 215 (a) Composite resin restoration

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3 217 All children from Group I will be treated according to conventional techniques
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5 218 using composite resin:

- 6
7 219 • Use local anesthesia;
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10 220 • Maintain absolute isolation of the operatory field with rubber dam and clamp;
11
12 221 • Remove caries: use hand excavators to remove caries in dentin. Both infected
13
14 222 and affected dentin should be removed from the dentin–enamel junction,
15
16 223 maintaining the affected dentin in the remaining dental walls. If necessary,
17
18 224 round bur at high speed under water cooling will be used to remove the
19
20 225 unsupported enamel;
21
22 226 • Etch enamel for 15 s and dentin for 7 s using 37% phosphoric acid, followed
23
24 227 by rinsing for the same amount of time and drying with compressed air;
25
26 228 • Apply the Adper Scotchbond Multipurpose adhesive system (3M/ESPE)
27
28 229 according to the manufacturer’s guidelines: primer application followed by
29
30 230 gentle drying for 5 s; then polymerization of the adhesive for 10 s with the XL
31
32 231 3000 curing light (3M/ESPE);
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34 232 • Apply light-cured Filtek Z350 resin (3M/ESPE) using the oblique incremental
35
36 233 placement technique. Each increment should be polymerized for 20 s. In
37
38 234 occlusal-proximal cavities, an adapted matrix strip should be used with a
39
40 235 wooden wedge to maintain it in place, providing appropriate contour to the
41
42 236 restoration;
43
44 237 • Remove the rubber dam and check the occlusion with articulating paper. If
45
46 238 necessary, finishing burs (F and FF) should be used under a cooling spray.
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54 240 (b) Atraumatic restorative treatment (ART) using glass ionomer cement (GIC)

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3 242 All children from Group II will be treated according to the ART philosophy as
4
5 243 described by Frencken:[22]

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7 244
- Maintain relative isolation of the operatory field with cotton rolls;
- 8
9 245
- Remove caries: using only hand excavators compatible with the size of the
- 10
11 246 carious cavity. Both infected and affected dentin should be removed from the
- 12
13 247 dentin–enamel junction. Thus, as described for Group I, the affected dentin
- 14
15 248 will be maintained in the remaining walls;
- 16
17 249
- Clean the cavity: cavity walls should be cleaned with cotton balls moistened
- 18
19 250 with water;
- 20
21 251
- Condition the dentin: apply a drop of 11.5% polyacrylic acid on a cotton ball
- 22
23 252 for 15 s. Then, wash the cavity with three cotton balls moistened with water
- 24
25 253 and dry using three more cotton balls;
- 26
27 254
- Use correct dosage (one spoon measure of the powder to one drop of
- 28
29 255 polyacrylic acid): place the polyacrylic acid flask vertically and upside down,
- 30
31 256 wait a few seconds until the bubbles rise and then drip two drops. Use the first
- 32
33 257 drop to condition the cavity, because this initial drop may contain bubbles;
- 34
35 258
- Hand mix: spread the second drop of polyacrylic acid over the paper pad.
- 36
37 259 Then, mix the powder in with the acid in two stages—manipulate the first part
- 38
39 260 for 10 s and the second part for 15–20 s, applying moderate pressure. Use the
- 40
41 261 material only while it remains glossy;
- 42
43 262
- Apply GIC: insert the GIC with a #1 spatula followed by finger pressure using
- 44
45 263 petroleum jelly. For occlusal-proximal cavities, use an adapted matrix strip
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47 264 with a wooden wedge to maintain it in place, providing appropriate contour to
- 48
49 265 the restoration. Protecting the restoration with petroleum jelly is necessary to
- 50
51 266 inhibit syneresis and imbibition;
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- 1
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3 267 • Check the occlusion: after the initial set (approximately 5 min), check the
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5 268 occlusion with articulating paper. If necessary, sharp hand instruments should
6
7 269 be used for adjustments. A new layer of petroleum jelly should be applied to
8
9
10 270 the surface of the restoration;
11
12 271 • Instruct the patient not to eat solid food for 1 h.

14 272 Dental care other than restorative treatment related to this project will also be
15
16 273 provided in the dental care trailer by three operators trained in the same philosophy
17
18 274 regarding non-cavitated carious lesions[23] and pulp treatment[24]. Moreover, all
19
20 275 participants and their respective legal guardians will receive verbal instructions about
21
22 276 the use of toothpaste with a minimum concentration of 1000 ppm fluoride to prevent
23
24 277 dental caries.[25]

27 278 The risks related to the present research are similar to those found during
28
29 279 conventional clinical dental treatment. Thus, there is no Data Monitoring Committee.
30
31 280 Independent surveillance of trial data collection, management and analysis will be
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33 281 undertaken by the principal investigator who has overall responsibility for the study
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35 282 and is in charge of the data.

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39 40 284 *Outcomes*

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43
44 286 The primary outcome will be the longevity of both restorative treatments after
45
46 287 follow-up for 2 years. Secondary outcomes will include the cost-efficacy of both
47
48 288 types of restorative treatment and self-reported discomfort.

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51 52 290 (I) Longevity

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3 291 Treatment longevity will be evaluated after 6, 12, 18 and 24 months by two
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5 292 trained examiners. The intra-examiner and inter-examiner concordances will be
6
7 293 calculated using Cohen's Kappa test. Only scores above 0.7 will be accepted. After
8
9
10 294 prophylaxis, the occlusal restorations will be clinically evaluated according to the
11
12 295 Frencken and Holmgren[26] criteria (Attachment B).

14 296 For occlusal-proximal restorations, the adopted criteria are those proposed by
15
16 297 Roeleveld et al.[27] (Attachment C). The width and depth of marginal defects, the
17
18 298 surface wear and the excess or lack of material will be measured using the WHO CPI
19
20
21 299 periodontal probe, which has a ball-shaped tip 0.5 mm in diameter.

23 300 If any treatment need is noted at the return visits, the procedure will be
24
25 301 performed by one of the three trained operators until the case is resolved. Oral
26
27 302 hygiene and fluoride use instructions will be repeated at each return visit for all
28
29
30 303 children.

32 304 Data from each participant will be registered in clinical records for future
33
34 305 statistical analysis. Data quality will be ensured by validation checks that include
35
36 306 missing data, out of range values, and illogical and invalid responses. All data entered
37
38 307 will be audited by the coordinator, and data queries will be raised as necessary.

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41 308

43 309 (II) Cost-efficacy

45 310 The direct cost analysis will be based on previous publications[28, 29]
46
47 311 adjusted to the Brazilian reality[30]. Both the professional cost and the procedure cost
48
49
50 312 will be considered.

52 313 To calculate the professional cost, we will use the previous calculation of
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54 314 Floriano et al.[31], such that the time spent in each session will be converted to hours
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56 315 and multiplied by the average income of a dentist per hour (\$13.89) and a dental

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3 316 assistant per hour (\$7.06) as ruled by the Brazilian federal law n° 3999/61.[30, 31] To
4
5 317 estimate the procedure cost, we will consider both the variable cost, which includes
6
7 318 electricity and the depreciation of instruments and equipment, and the materials
8
9
10 319 cost.[28, 32] To calculate the instruments and equipment depreciation (peripherals
11
12 320 and dental chair), we will use the previous calculation of Da Mata et al.[18] and
13
14 321 Floriano et al.[29] that considers their cost, a lifespan of 3 years for instruments[18]
15
16 322 and 5 years for equipment[30] and a monthly use of 160 h.

17
18 323 A researcher other than the operator will time each restorative treatment
19
20 324 session, including the return visits, and will register in predetermined sheets the
21
22 325 specifications and quantity of all materials used. Prices will be inferred from the
23
24 326 market value converted to US dollars and obtained by averaging the values from
25
26 327 different places that have commercialized the products used. The prices will also be
27
28 328 updated during the course of the study.

29
30 329 In order to estimate the cost-efficacy, the incremental cost-efficacy ration
31
32 330 (ICER) will be estimated by dividing the average total cost by the survival after 2
33
34 331 years of each treatment:

$$332 \quad \text{ICER} = (\text{cost}_{\text{ART}} - \text{efficacy}_{\text{ART}}) / (\text{cost}_{\text{TC}} - \text{efficacy}_{\text{TC}})$$

333
334 (III) Child self-reported discomfort

335 The self-reported discomfort of each child will be evaluated using the Wong-
336 Baker Facial Scale.[33] This scale indicates the discomfort of an individual who has
337 to choose among six faces, each one expressing different facial expressions. The first
338 image is a smiling happy face, followed by gradually less cheerful expressions up to
339 the last one, which is a very sad face covered in tears. The scale will be applied
340 immediately after each restorative treatment session by the operator who is timing the
341 procedure.

1
2
3 342 The participant will be asked to choose the face that best match how he or she
4
5 343 felt during the treatment. This answer should be given solely by the child, with no
6
7 344 parental or professional interference.[34]
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11 346 *Data analysis*

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14 347 To compare the longevity of the restorations, both Kaplan–Meier survival
15
16 348 analysis and Cox regression with shared frailty will be applied. The association
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18 349 between restoration longevity and caries experience or the type of cavity will also be
19
20 350 evaluated using Cox’s Regression with shared frailty. To determine the data
21
22 351 normality, the Kolmogorov–Smirnov test will be used. In relation to the secondary
23
24 352 outcomes, the comparison between groups in relation to the time spent in each
25
26 353 procedure as well as the average cost of a restoration will be done through the use of
27
28 354 linear regression adjusted to the cluster effect. Multilevel Poisson regression will be
29
30 355 used to compare both groups and the other independent variables to the self-reported
31
32 356 discomfort. The significance level will be adjusted to 5%.

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38 358 **Ethics and dissemination**

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40 359 This clinical trial was approved by the Ethics Committee of Research in
41
42 360 Humans from the Faculty of Dentistry of the University of Sao Paulo (registration
43
44 361 #1.556.018). Participants will be included after their parents or legal guardians have
45
46 362 signed an informed consent form containing detailed information about the research.

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49 363 This study will involve the publication of grouped data collected from
50
51 364 participants’ individual information. This statement will be described in the consent
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53 365 form of each participant.

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2
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4

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8

9
10 370

11 371 **Authors' contributions**

12 372 DPR, MMB, FMM and IF contributed to the conception of this trial. DPR was
13
14 373 responsible for its design. DPR is the trial coordinator and NML is the principal
15
16 374 investigator. DPR, NML and IO drafted the protocol. IF is in charge of the
17
18 375 recruitment of participants. NML is responsible for the patients' treatment. CSS and
19
20 376 LY are responsible for timekeeping, recording materials and organizing treatment.
21
22 377 TKT is responsible for patient evaluations over time. All authors critically reviewed
23
24 378 and approved the final manuscript as submitted.
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30 379

31 380 **Competing interests**

32 381 We declare that there are no conflicts of interest regarding the performance of this
33
34 382 trial.
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38 383

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53 391 **References**
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2
3 392 1. Dhar V, Hsu KL, Coll JA, Ginsberg E, Ball BM et al. Evidence-based update
4
5 393 of pediatric dental restoration procedures: dental materials. *Journal of Clinical*
6
7 394 *Pediatric Dentistry* 2015; 39(4): 303-10.
- 8
9 395 2. Casagrande L, Dalpian DM, Ardenghi TM, Zanatta FB, Balbinot CEA et al.
10
11 396 Randomized clinical trial of adhesive restorations in primary molars. 18-
12
13 397 month results. *American Journal of Dentistry* 2013; 26 (6): 351-55.
- 14
15 398 3. Yengopal V, Harnekar SY, Patel N, Siegfried N. Dental filling for the
16
17 399 treatment of caries in the primary dentition. *Cochrane Database of Systematic*
18
19 400 *Reviews*. 2009; doi: 10.1002/14651858.
- 20
21 401 4. Mickenautsch S, Yengopal V, Banerjee A. Atraumatic restorative treatment
22
23 402 versus amalgam restoration longevity: A systematic review. *Clinical Oral*
24
25 403 *Investigations* 2010; 14: 233-240.
- 26
27 404 5. Raggio DP, Hesse D, Lenzi TL, Guglielmi CAB, Braga MM. Is atraumatic
28
29 405 restorative treatment an option for restoring occlusoproximal caries lesions in
30
31 406 primary teeth? A systematic review and meta-analysis. *International Journal of*
32
33 407 *Paediatric Dentistry* 2012; 23: 435-43.
- 34
35 408 6. Qvist V, Poulsen A, Teglers PT, Mjör IA. The longevity of different
36
37 409 restorations in primary teeth. *International Journal of Paediatric Dentistry*
38
39 410 2010; 20: 1–7.
- 40
41 411 7. Heintze SD, Rousson V. Clinical effectiveness of direct Class II restoration: a
42
43 412 meta-analysis. *The Journal of Adhesive Dentistry* 2012; 14(5): 407-31.
- 44
45 413 8. Schriks MC, van Amerongen WE. Atraumatic perspectives of ART:
46
47 414 psychological and physiological aspects of treatment with and without rotary
48
49 415 instruments. *Community Dentistry and Oral Epidemiology* 2003; 31: 15–20.
- 50
51 416 9. Frencken JE, Pilot T, Songpaisan Y, Phantumvait P. Atraumatic restorative
52
53
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59
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2
3 417 treatment (ART): Rationale, technique, and development. *Journal of Public*
4
5 418 *Health Dentistry*. 1996; 56(3): 135-140.
6
7 419 10. Frencken JE. The State-of-Art of ART restorations. *Dental Update* 2014;
8
9 420 41(3):218-20.
10
11 421 11. van't Hof MA, Frencken JE, Van Palenstein Helderma WH, Holmgren WH.
12
13 422 The atraumatic restorative treatment (ART) approach for managing dental
14
15 423 caries: a meta-analysis. *International Dental Journal* 2006; 56(6): 345-51.
16
17 424 12. van Dijken JWV, Pallesen U. Long-term dentin retention of etch-and-rinse
18
19 425 and self-etch adhesives and a resin-modified glass ionomer cement in non-
20
21 426 carious cervical lesion. *Dental Materials* 2008; 24: 915–22.
22
23 427 13. Fuks AB, Araujo FB, Osorio LB, Hadami PE, Pinto AS. Clinical and
24
25 428 radiographic assessment of class II esthetic restorations in primary molars.
26
27 429 *Journal of Pediatric Dentistry* 2000; 22(5): 479-85.
28
29 430 14. Ersin NK, Candan U, Aykut A, Oncag O, Eronat C, Kose T. A clinical
30
31 431 evaluation of resin-based composite and glass-ionomer cement restorations
32
33 432 placed in primary teeth using the ART approach. *Journal of the American*
34
35 433 *Dental Association* 2006; 137: 1529-36.
36
37 434 15. Alves dos Santos MP, Luiz RR, Maia LC. Randomized trial of resin-based
38
39 435 restorations in class I and class II beveled preparations in primary molars: 48-
40
41 436 month results. *Journal of Dentistry*. 2010; 38(6): 451-59.
42
43 437 16. Novaes TF, Matos R, Raggio DP, Braga MM, Mendes FM. Children's
44
45 438 discomfort in assessments using different methods for approximal caries
46
47 439 detection. *Braz. Oral Res.* 2012; 26(2): 93-99.
48
49 440 17. Staman NM, Townsend JA, Hagan JL. Observational study: discomfort
50
51 441 following dental procedures for children. *Pediatr. Dent.* 2013; 35(1): 52-4.
52
53
54
55
56
57
58
59
60

- 1
2
3 442 18. Da Mata C, Allen PF, Cronin M, O'Mahony D, McKenna G, Woods N.
4
5 443 Cost-effectiveness of ART restorations in elderly adults: a randomized clinical
6
7 444 trial. *Community Dentistry and Oral Epidemiology* 2014; 42: 79-87.
8
9
10 445 19. Mickenautsch S, Munshi I, Grossman ES. Comparative cost of Art and
11
12 446 conventional treatment within a dental school clinic. *Journal of Minimum*
13
14 447 *Intervention in Dentistry*. 2009; 2(2): 135-145.
15
16 448 20. WHO (World Health Organization). *Oral health surveys: basic methods*. 3ed.
17
18 449 Geneva: World Health Organization; 1997. (20)
19
20
21 450 21. Brasil. Ministério da Saúde (MS). *Projeto SB Brasil 2010: condições de saúde*
22
23 451 *bucal da população brasileira 2009-2010. Resultados principais*. Brasília:
24
25 452 2012.
26
27 453 22. Frencken JE. Survival of single surface ART-restorations in Zimbabwe after 3
28
29 454 years. *Nederlands Tijdschrift voor Tandheelkunde* 1999; 106(6): 214-8.
30
31
32 455 23. Gibson G, Jurasic MM, Wehler CJ, Jones JA. Supplemental fluoride use for
33
34 456 moderate and high caries risk adults: a systematic review. *Journal of Public*
35
36 457 *Health Dentistry* 2011;71(3):171-84.
37
38 458 24. Cerqueira DF, Mello-Moura AC, Santos EM, Guedes-Pinto AC. Cytotoxicity,
39
40 459 histopathological, microbiological and clinical aspects of an endodontic
41
42 460 iodoform-based paste used in pediatric dentistry: a review. *Journal of Clinical*
43
44 461 *Pediatric Dentistry* 2008;32(2):105-10.
45
46
47 462 25. Walsh T, Worthington HV, Glenny AM, Appelbe P, Marinho VC, Shi X.
48
49 463 Fluoride toothpastes of different concentrations for preventing dental caries in
50
51 464 children and adolescents. *Cochrane Database Systematic Review* 2010; 20(1):
52
53 465 1-221
54
55
56 466 26. Frencken JE, Holmgren CF. Tratamento restaurador atraumático (ART) para a
57
58
59
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2
3 467 cárie dentária. São Paulo: Santos. 2001.
- 4
5 468 27. Roeleveld AC, Van Amerongen WE, Mandari GJ. Influence of residual caries
6
7 469 and cervical gaps on the survival rate of Class II glass ionomer restorations.
8
9 470 European Archives of Paediatric Dentistry 2006; 7(2): 85-91.
- 10
11 471 28. Takanashi Y, Penrod JR, Lund JP, Feine JS. A cost comparison of mandibular
12
13 472 two-implant overdenture and conventional denture treatment. International
14
15 473 Journal of Prosthodontics 2004; 17: 181-86
- 16
17 474 29. Oscarson N, Kallestal C, Fjelddahl A, Lindholm L. Cost effectiveness of
18
19 475 different caries preventive measures in a high-risk population of Swedish
20
21 476 adolescents. Community Dentistry and Oral Epidemiology 2003; 31(3): 169-
22
23 477 178.
- 24
25 478 30. Floriano I, Gimenez R, Reyes A, Matos R, Mattos-Silveira, J, Mendes FM.;
26
27 479 Braga MM. Análise de custos de diferentes abordagens para avaliação de
28
29 480 lesões de cárie em dentes decíduos. Brazilian Oral Research. 2013; 27(1): 41-
30
31 481 9.
- 32
33 482 31. Morita MC, Haddad AE, Araújo ME. Perfil atual e tendências do cirurgião-
34
35 483 dentista brasileiro. Maringá: Dental Press Internacional. 2010.
- 36
37 484 32. Kawai Y, Murakami H, Takanashi Y, Lund JP, Feine JS. Efficient resource
38
39 485 use in simplified complete denture fabrication. Journal of Prosthodontics
40
41 486 2010; 19: 512-16.
- 42
43 487 33. Wong DL, Baker CM. Pain in children: comparison of assessment scales.
44
45 488 Pediatric Nursing. 1988; 14(1): 9-17.
- 46
47 489 34. Novaes TF, Matos R, Raggio DP, Imperato JC, Braga MM, Mendes FM.
48
49 490 Influence of the discomfort reported by children on the performance of
50
51 491 approximal caries detection methods. Caries Research. 2010; 44(5): 465-71.
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SPIRIT 2013 Checklist: Recommended items to address in a clinical trial protocol and related documents*

Section/item	Item No	Description	Addressed on page number
Administrative information			
Title	1	Descriptive title identifying the study design, population, interventions, and, if applicable, trial acronym	01
Trial registration	2a	Trial identifier and registry name. If not yet registered, name of intended registry	04
	2b	All items from the World Health Organization Trial Registration Data Set	_____
Protocol version	3	Date and version identifier	04
Funding	4	Sources and types of financial, material, and other support	15
Roles and responsibilities	5a	Names, affiliations, and roles of protocol contributors	01, 02
	5b	Name and contact information for the trial sponsor	02
	5c	Role of study sponsor and funders, if any, in study design; collection, management, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication, including whether they will have ultimate authority over any of these activities	16
	5d	Composition, roles, and responsibilities of the coordinating centre, steering committee, endpoint adjudication committee, data management team, and other individuals or groups overseeing the trial, if applicable (see Item 21a for data monitoring committee)	_____

1
2
3 **Introduction**
4

5 Background and rationale	6a	Description of research question and justification for undertaking the trial, including summary of relevant studies (published and unpublished) examining benefits and harms for each intervention	05
	6b	Explanation for choice of comparators	05
10 Objectives	7	Specific objectives or hypotheses	06
12 Trial design	8	Description of trial design including type of trial (eg, parallel group, crossover, factorial, single group), allocation ratio, and framework (eg, superiority, equivalence, noninferiority, exploratory)	06

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16 **Methods: Participants, interventions, and outcomes**
17

18 Study setting	9	Description of study settings (eg, community clinic, academic hospital) and list of countries where data will be collected. Reference to where list of study sites can be obtained	07
21 Eligibility criteria	10	Inclusion and exclusion criteria for participants. If applicable, eligibility criteria for study centres and individuals who will perform the interventions (eg, surgeons, psychotherapists)	07
24 Interventions	11a	Interventions for each group with sufficient detail to allow replication, including how and when they will be administered	09, 10, 11, 12
	11b	Criteria for discontinuing or modifying allocated interventions for a given trial participant (eg, drug dose change in response to harms, participant request, or improving/worsening disease)	_____
	11c	Strategies to improve adherence to intervention protocols, and any procedures for monitoring adherence (eg, drug tablet return, laboratory tests)	_____
	11d	Relevant concomitant care and interventions that are permitted or prohibited during the trial	_____
35 Outcomes	12	Primary, secondary, and other outcomes, including the specific measurement variable (eg, systolic blood pressure), analysis metric (eg, change from baseline, final value, time to event), method of aggregation (eg, median, proportion), and time point for each outcome. Explanation of the clinical relevance of chosen efficacy and harm outcomes is strongly recommended	12, 13, 14
41 Participant timeline	13	Time schedule of enrolment, interventions (including any run-ins and washouts), assessments, and visits for participants. A schematic diagram is highly recommended (see Figure)	08

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Sample size	14	Estimated number of participants needed to achieve study objectives and how it was determined, including clinical and statistical assumptions supporting any sample size calculations	07
Recruitment	15	Strategies for achieving adequate participant enrolment to reach target sample size	08

Methods: Assignment of interventions (for controlled trials)

Allocation:

Sequence generation	16a	Method of generating the allocation sequence (eg, computer-generated random numbers), and list of any factors for stratification. To reduce predictability of a random sequence, details of any planned restriction (eg, blocking) should be provided in a separate document that is unavailable to those who enrol participants or assign interventions	09
Allocation concealment mechanism	16b	Mechanism of implementing the allocation sequence (eg, central telephone; sequentially numbered, opaque, sealed envelopes), describing any steps to conceal the sequence until interventions are assigned	09
Implementation	16c	Who will generate the allocation sequence, who will enrol participants, and who will assign participants to interventions	08 e 09
Blinding (masking)	17a	Who will be blinded after assignment to interventions (eg, trial participants, care providers, outcome assessors, data analysts), and how	09
	17b	If blinded, circumstances under which unblinding is permissible, and procedure for revealing a participant's allocated intervention during the trial	_____

Methods: Data collection, management, and analysis

Data collection methods	18a	Plans for assessment and collection of outcome, baseline, and other trial data, including any related processes to promote data quality (eg, duplicate measurements, training of assessors) and a description of study instruments (eg, questionnaires, laboratory tests) along with their reliability and validity, if known. Reference to where data collection forms can be found, if not in the protocol	12
	18b	Plans to promote participant retention and complete follow-up, including list of any outcome data to be collected for participants who discontinue or deviate from intervention protocols	_____

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3	Data management	19	Plans for data entry, coding, security, and storage, including any related processes to promote data quality (eg, double data entry; range checks for data values). Reference to where details of data management procedures can be found, if not in the protocol	06
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7	Statistical methods	20a	Statistical methods for analysing primary and secondary outcomes. Reference to where other details of the statistical analysis plan can be found, if not in the protocol	15
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10		20b	Methods for any additional analyses (eg, subgroup and adjusted analyses)	15
11				
12		20c	Definition of analysis population relating to protocol non-adherence (eg, as randomised analysis), and any statistical methods to handle missing data (eg, multiple imputation)	
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16	Methods: Monitoring			
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18	Data monitoring	21a	Composition of data monitoring committee (DMC); summary of its role and reporting structure; statement of whether it is independent from the sponsor and competing interests; and reference to where further details about its charter can be found, if not in the protocol. Alternatively, an explanation of why a DMC is not needed	12
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23		21b	Description of any interim analyses and stopping guidelines, including who will have access to these interim results and make the final decision to terminate the trial	
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26	Harms	22	Plans for collecting, assessing, reporting, and managing solicited and spontaneously reported adverse events and other unintended effects of trial interventions or trial conduct	06, 12
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29	Auditing	23	Frequency and procedures for auditing trial conduct, if any, and whether the process will be independent from investigators and the sponsor	12
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33	Ethics and dissemination			
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35	Research ethics approval	24	Plans for seeking research ethics committee/institutional review board (REC/IRB) approval	15
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38	Protocol amendments	25	Plans for communicating important protocol modifications (eg, changes to eligibility criteria, outcomes, analyses) to relevant parties (eg, investigators, REC/IRBs, trial participants, trial registries, journals, regulators)	
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Consent or assent	26a	Who will obtain informed consent or assent from potential trial participants or authorised surrogates, and how (see Item 32)	07, 15
	26b	Additional consent provisions for collection and use of participant data and biological specimens in ancillary studies, if applicable	_____
Confidentiality	27	How personal information about potential and enrolled participants will be collected, shared, and maintained in order to protect confidentiality before, during, and after the trial	06
Declaration of interests	28	Financial and other competing interests for principal investigators for the overall trial and each study site	16
Access to data	29	Statement of who will have access to the final trial dataset, and disclosure of contractual agreements that limit such access for investigators	06
Ancillary and post-trial care	30	Provisions, if any, for ancillary and post-trial care, and for compensation to those who suffer harm from trial participation	06
Dissemination policy	31a	Plans for investigators and sponsor to communicate trial results to participants, healthcare professionals, the public, and other relevant groups (eg, via publication, reporting in results databases, or other data sharing arrangements), including any publication restrictions	06
	31b	Authorship eligibility guidelines and any intended use of professional writers	_____
	31c	Plans, if any, for granting public access to the full protocol, participant-level dataset, and statistical code	_____
Appendices			
Informed consent materials	32	Model consent form and other related documentation given to participants and authorised surrogates	_____
Biological specimens	33	Plans for collection, laboratory evaluation, and storage of biological specimens for genetic or molecular analysis in the current trial and for future use in ancillary studies, if applicable	_____

*It is strongly recommended that this checklist be read in conjunction with the SPIRIT 2013 Explanation & Elaboration for important clarification on the items. Amendments to the protocol should be tracked and dated. The SPIRIT checklist is copyrighted by the SPIRIT Group under the Creative Commons "[Attribution-NonCommercial-NoDerivs 3.0 Unported](https://creativecommons.org/licenses/by-nc-nd/3.0/)" license.

Attachment B – Assessment criteria by Frencken and Holmgren (2001)

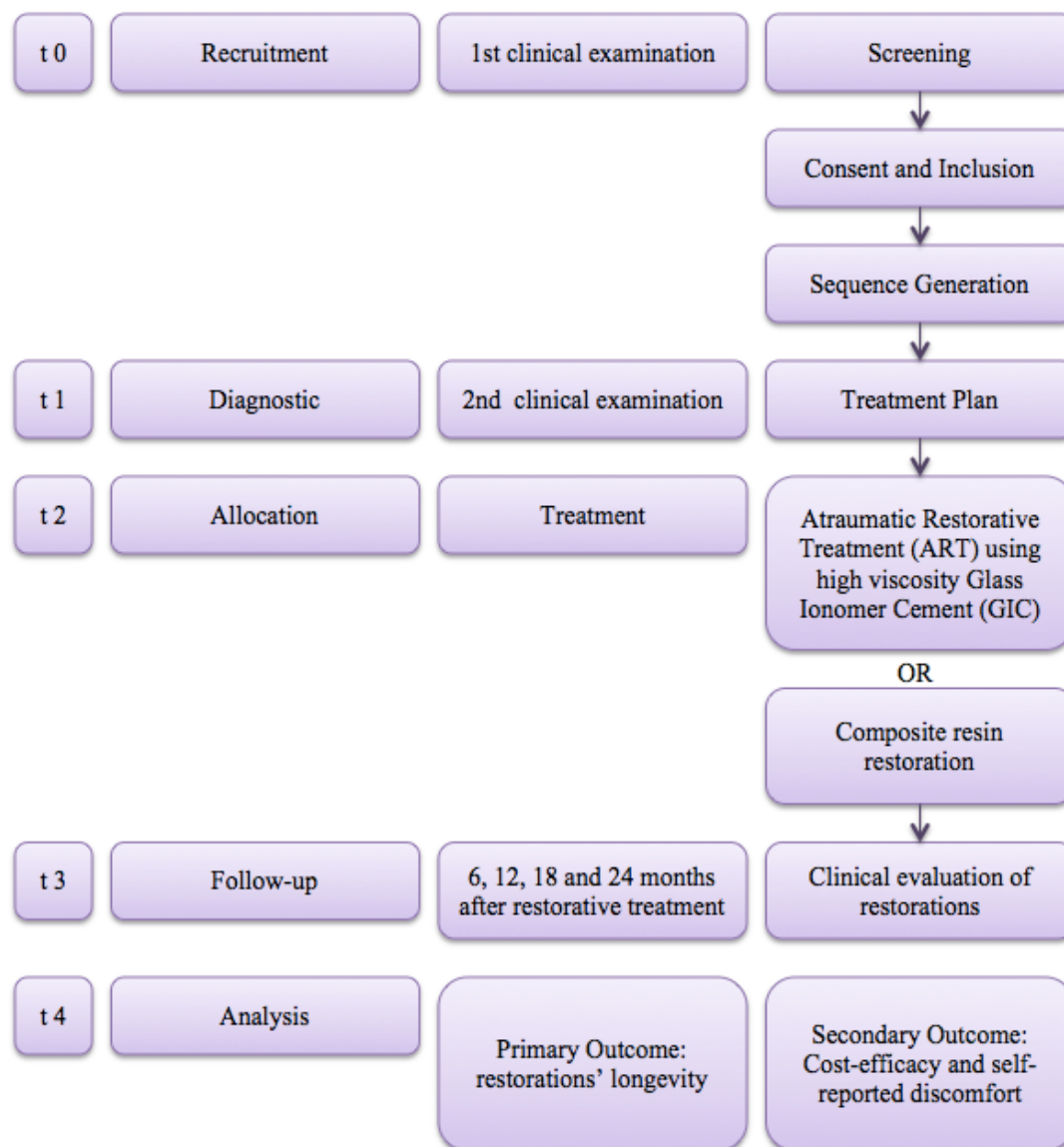
Score	Criteria
0	Present, good
1	Present, slight marginal defect for whatever reason, at any one place, which is less than 0.5 mm in depth. No repair is needed
2	Present, marginal defect for whatever reason, at any one place which is deeper than 0.5 mm but less than 1.0 mm. Repair is needed
3	Present, gross defect of more than 1.0 mm in depth. Repair is needed
4	Not present, restoration has (almost) completely disappeared. Treatment is needed
5	Not present, other restorative treatment has been performed
6	Not present, tooth has been extracted
7	Present, wear and tear gradually over larger parts of the restoration but are less than 0.5 mm at the deepest point. No repair is needed
8	Present, wear and tear gradually over larger parts of the restoration which are deeper than 0.5 mm. Repair is needed
9	Unable to diagnose

Note: Restorations considered to have survived are scored by codes: 0, 1 and 7; those considered to have failed by codes: 2, 3, 4 and 8; while those that are considered to be unrelated to success and failure are coded: 5 and 6.

Attachment C – Assessment criteria by Roeleveld et al. (2006)

Score	Criteria
00	Restoration still present, correct
10	Restoration present, slight defect at the margin and/or wear of the surface; < 0.5 mm in depth, repair needed
11	Restoration present, defect at the margin and/or wear of the surface; > 0.5 mm in depth, repair needed
12	Restoration present; underfilled > 0.5 mm, no gap, repair needed
13	Restoration overfilled > 0.5 mm, repair needed
20	Secondary caries, discoloration in depth, surface hard and intact, caries within dentin; repair needed
21	Secondary caries. Surface defect, caries within dentin; repair needed
30	Restoration not present, bulk fracture, loose, (partly) lost; repair needed (if still possible without exposing the pulp)
40	Inflammation of the pulp (restoration still in situ, not categorized in the former categories); fistula or severe pain complaints; extraction needed
50	Tooth not present because of extraction
60	Tooth not present because of shedding
70	Tooth not present because of extraction
90	Patient not present

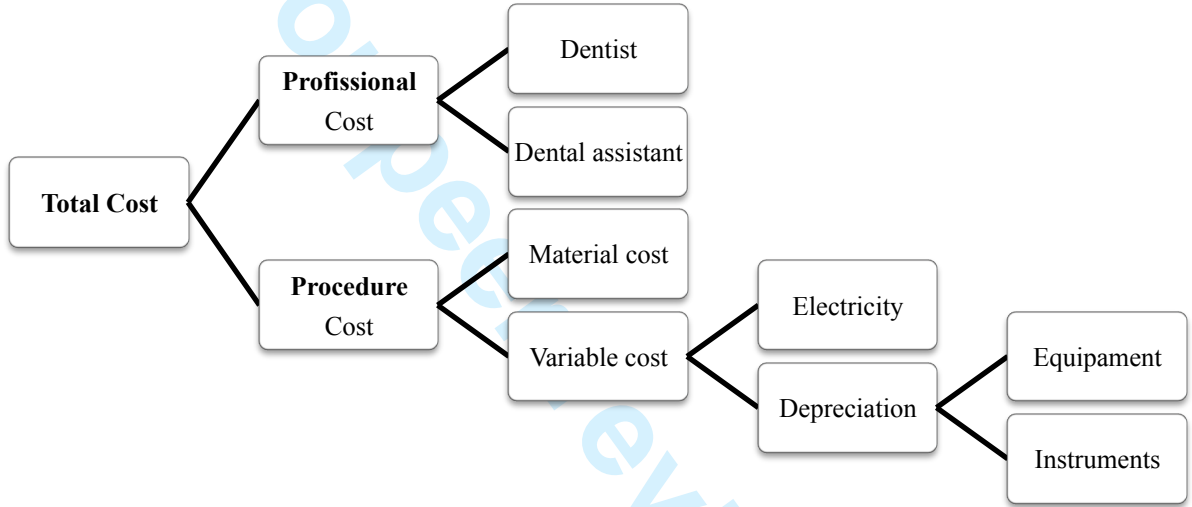
Note: Restorations considered to have survived are scored by codes: 00 and 10; those considered to have by code: 11, 12, 13, 20, 21, 30 or 40; while those considered to be unrelated to success and failure are coded: 50, 60, 70 or 90



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BMJ Open

Efficacy of conventional treatment with composite resin and atraumatic restorative treatment in posterior primary teeth: study protocol for a randomized controlled trial

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-015542.R1
Article Type:	Protocol
Date Submitted by the Author:	26-Apr-2017
Complete List of Authors:	Ladewig, Nathalia; Universidade de Sao Paulo Faculdade de Odontologia, Orthodontics and Pediatric Dentistry Saihara, Cintia ; Universidade de Sao Paulo Faculdade de Odontologia, Orthodontics and Pediatric Dentistry Yoshioka, Laysa ; Universidade de Sao Paulo Faculdade de Odontologia, Orthodontics and Pediatric Dentistry Olegário, Isabel; Universidade de Sao Paulo Faculdade de Odontologia, Orthodontics and Pediatric Dentistry Floriano, Isabela; Universidade de Sao Paulo Faculdade de Odontologia, Orthodontics and Pediatric Dentistry Tedesco, Tamara; Universidade Ibirapuera, Pediatric Dentistry Mendes, Fausto; Universidade de Sao Paulo Faculdade de Odontologia, Orthodontics and Pediatric Dentistry Braga, Mariana; Universidade de Sao Paulo Faculdade de Odontologia, Orthodontics and Pediatric Dentistry Raggio, Daniela; Universidade de Sao Paulo Faculdade de Odontologia, Orthodontics and Pediatric Dentistry
Primary Subject Heading:	Dentistry and oral medicine
Secondary Subject Heading:	Dentistry and oral medicine, Health economics, Paediatrics, Patient-centred medicine
Keywords:	HEALTH ECONOMICS, ORAL MEDICINE, PAEDIATRICS

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Manuscripts

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3 1 Efficacy of conventional treatment with composite resin and atraumatic
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5 2 restorative treatment in posterior primary teeth: study protocol for a
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7 3 randomized controlled trial
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51 **Abstract**

52 **Introduction:** Despite the widespread acceptance of conventional treatment using
53 composite resin in primary teeth, there is limited evidence that this approach is the
54 best option in pediatric clinics. Atraumatic restorative treatment (ART) using high-
55 viscosity glass ionomer cement (GIC) has gradually become more popular because it
56 performs well in clinical studies, is easy to handle and is patient friendly. Therefore,
57 the aim of this randomized clinical trial study is to compare the restoration longevity
58 of conventional treatment using composite resin with that of ART in posterior
59 primary teeth. As secondary outcomes, cost-efficacy and patient self-reported
60 discomfort will also be tested.

61 **Methods and analysis:** Children aged 3 to 6 years presenting with at least one
62 occlusal and/or occlusal-proximal cavity will be randomly assigned to one of two
63 groups according to the dental treatment: ART (experimental group) or composite
64 resin restoration (control group). The dental treatment will be performed at a dental
65 care trailer located in an Educational Complex in Barueri/SP, Brazil. The unit of
66 randomization will be the child. A sample size of 240 teeth with occlusal cavities and
67 188 teeth with occlusal-proximal cavities has been calculated. The primary outcome
68 will be restoration longevity, which will be clinical assessed after 6, 12, 18 and 24
69 months by two examiners. The duration of the dental treatment and the cost of all
70 materials used will be considered when estimating the cost-efficacy of each treatment.
71 Individual discomfort will be measured after each dental procedure using the Facial
72 Scale of Wong-Baker.

73 **Ethics and dissemination:** This clinical trial was approved by the Local Ethics
74 Committee from the Faculty of Dentistry of the University of Sao Paulo (registration

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2
3 75 #1.556.018). Participants will be included after their legal guardians have signed an
4
5 76 informed consent form containing detailed information about the research.
6

7 77 **Trial registration:** www.clinicaltrials.gov, NCT02562456. Registered on September
8
9 78 25th 2015.
10

11 79 **Keywords:** restorative dental treatment, primary teeth, composite resin, glass
12
13 80 ionomer cement, atraumatic restorative treatment, randomized clinical trial, cost-
14
15 81 efficacy analysis
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20 21 83 **Strengths and limitations of this study**

- 22
23 84 • Considering that the success of a restorative treatment is intrinsically related to
24
25 85 the handling of the material, it seems necessary to study these techniques
26
27 86 under controlled conditions to extract from them the best clinical performance
28
29 87 they can offer;
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31 88 • An efficacy study can maximize the likelihood of observing an intervention
32
33 89 effect by investigating the benefits and harms of it under highly controlled
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35 90 conditions;
36
37 91 • This is the first clinical trial comparing the longevity, cost-efficacy and self-
38
39 92 reported discomfort assessment between conventional restoration using
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41 93 composite resin and ART with high-viscosity GIC in posterior primary teeth;
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43 94 • Blinding of operators and patients will not be possible because of the evident
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45 95 differences between the techniques.
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100 **Introduction**

101 Restorative care in primary teeth is part of the comprehensive oral health treatment of
102 children and adolescents,[1] which should guarantee appropriate functional and
103 aesthetic conditions until tooth exfoliation.[2] There is an ongoing search for ideal
104 restorative materials for use in pediatric dentistry,[1] but a lack of evidence
105 persists.[3, 4, 5]

106 Conventional treatment using composite resin is still one of the most common
107 approaches used in pediatric dental clinics.[6] Despite the aesthetic quality,
108 preservation of dental structure, and abrasion wear rate similar to that of natural
109 primary teeth,[6] all composite resins suffer polymerization shrinkage, which can
110 jeopardize marginal integrity[2] and restoration longevity. Additionally, to take full
111 advantage of the properties of composite resin, absolute isolation with rubber dam is
112 necessary,[7] making the restoration not only technique-sensitive and time-
113 consuming,[2] but also more traumatic for the pediatric patient.[8]

114 An alternative to the use of composite resin is atraumatic restorative treatment
115 (ART), a minimal intervention approach that simplifies the restorative procedure
116 through the exclusive use of hand instruments, followed by the application of a
117 chemical-adhesive material.[9] ART is reported to provoke less anxiety and less pain,
118 and rarely requires local anesthesia.[10] Currently, the material of choice for ART is
119 high-viscosity glass ionomer cement (GIC),[11] which provides biocompatibility,
120 fluoride release, chemical adhesion to the tooth surface[12] and a coefficient of
121 thermal expansion similar to that of natural teeth.[4] Moreover, it is easy to use
122 because it can be placed in a single increment.[2]

123 The international scientific literature has already designated ART as an
124 appropriate procedure to treat occlusal and occlusal-proximal cavities in primary teeth

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3 125 when compared with amalgam.[4, 5] However, few clinical studies have compared
4
5 126 composite resin performance in primary teeth with any other dental material.[13, 14,
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7 127 15] Moreover, patient-based parameters must also be assessed in order to enable a
8
9 128 more effective and appropriate choice of treatment for each individual. In this context,
10
11 129 few reports have been found in the literature regarding those outcomes such as
12
13 130 patient's acceptability [16, 17] (Novaes et al., 2012; Staman et al., 2013) and cost of
14
15 131 restorative treatments.[18,19] (Da Mata et al., 2014; Mickenautsch et al., 2009).

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17
18 132 Because of the need to establish the best scientific evidence about restorative
19
20 133 treatment in primary teeth, this study aims to compare the efficacy of two types of
21
22 134 treatment in primary molars (ART using high-viscosity GIC and composite resin
23
24 135 restoration) using a superiority randomized clinical trial with parallel arms.

25
26
27 136 Our hypothesis is that the longevity of restorations using the conventional
28
29 137 treatment with resin composite under rubber dam for occlusal and occlusal-proximal
30
31 138 cavities in primary molars differs from the longevity of atraumatic restorations using
32
33 139 high viscosity glass ionomer. Regarding the secondary outcomes, we expect that ART
34
35 140 has a better cost-efficacy and it is the only treatment highly accepted among children
36
37 141 in this study.

142 143 **Methods/Design**

144 The present protocol follows the guidelines of the Standard Protocol Items:
145 Recommendations for Interventional Trials (SPIRIT) as detailed in Attachment A.

146 This clinical trial was recorded in the database for registration of clinical
147 studies (Clinicaltrials.gov registration NCT02562456). This study is part of a
148 partnership with the city of Barueri, São Paulo, and it is nested to the Caries Detection
149 in Children-2 study (registration NCT02473107). Each participant will be encoded by

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2
3 150 a number to guarantee information confidentiality. Any files containing identifiable
4
5 151 data will be stored in locked filing cabinets, and only researchers will have access to
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7 152 participants' information.
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9
10 153 The final trial dataset will be available for inspection with the coordinator's
11
12 154 endorsement. Results will be fully reported in peer-reviewed journals, the patients'
13
14 155 newsletter and on the website. If participants develop any dental treatment needs after
15
16 156 completion of the trial, they will be referred to the health service of the city of
17
18 157 Barueri, São Paulo.
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22
23 159 *Sample description*
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25 160 Participants will be selected after screening in a dental care trailer located in
26
27 161 the Professor Carlos Osmarinho de Lima Educational Complex (Barueri/SP). All
28
29 162 healthy children who live in the city of Barueri seeking dental treatment are potential
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31 163 participants in our project. The trailer is set up as a regular dental office. The
32
33 164 inclusion criteria are: 1) children aged 3–6 years; 2) whose parents consent their
34
35 165 participation in the research; 3) with at least one occlusal and/or occlusal-proximal
36
37 166 cavity in a primary molar; 4) the carious lesion should be in dentin, clinically
38
39 167 classified as a shallow or a medium cavity; 5) the tooth of interest should not be
40
41 168 associated with a fistula, abscess, pulp exposure, history of spontaneous dental pain or
42
43 169 mobility; and 6) the cavity of interest should allow the access by the operator using
44
45 170 hand instruments (ICDAS 5 or 6). Children who present behavior problems during the
46
47 171 clinical examination or during dental treatment will be excluded from our study.
48
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50
51 172 The child will be set as the unit of randomization, which means that all
52
53 173 eligible teeth of a child included in our research will be treated according to the same
54
55 174 treatment independently of the number of cavities. For sample size calculation, data
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3 175 on the longevity of 2 years of occlusal and occlusal-proximal composite resin
4
5 176 restorations[15] were extracted from the literature as 86% and 60%, respectively. A
6
7 177 minimum difference of 10% between treatment longevities was set as the superiority
8
9
10 178 limit. Taking the significance level as 5%, a power of 80% and the addition of 40%
11
12 179 owing to study design (cluster per children), the minimum number of teeth per group
13
14 180 was calculated using a two-tailed test. Additionally, a sample loss of 20% was
15
16 181 estimated, resulting in 204 teeth for the occlusal group and 240 teeth for the occlusal-
17
18 182 proximal group (Table 1).
19

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21 18322
23 184

Table 1 – Sample distribution.

Groups	Type of cavity	
	Occlusal	Occlusal-proximal
Control (Composite resin)	102	120
Experimental (ART)	102	120
Total	204	240

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41 186 Recruitment will take place from December 2015 to June 2017. Each
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43 187 participant will be enrolled in the study for about 25 months: 1 month for the
44
45 188 Randomized Clinical Trial (RCT) diagnosis and treatment, followed by a 24-month
46
47 189 observation period. Details are illustrated in Figure 1. Participants' enrolment will be
48
49 190 facilitated by locating the trailer inside an Educational Complex.
50

51
52 191 After screening, participants who have met the eligibility criteria will have
53
54 192 their registration data collected and will be clinically examined by one operator.
55
56 193 Radiographic examination will be performed if any doubts about the pulp
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3 194 involvement of the tooth of interest persist. As the child will receive complete dental
4
5 195 treatment during the study, radiographic examination will also be used if any other
6
7 196 treatment need demand it.
8

9
10 197 The same operator will also determine the dental caries experience of the child
11
12 198 which will be assessed based on the World Health Organization (WHO) criteria that
13
14 199 only considers evident carious cavities, and restored and/or missing teeth as a result of
15
16 200 carious progression.[20] Thus, the following indices will be calculated for each child:
17
18 201 def-t and DMFT; children in whom (def-t) + (DMFT) is lower than or equal to three
19
20 202 will be classified as having low dental caries experience. Children with higher scores
21
22 203 will be classified as having high dental caries experience.[21]
23

24
25 204 The randomization process will be designed in blocks of different sizes
26
27 205 generated by software. Opaque, sealed and sequentially numbered envelopes will be
28
29 206 used to randomize the participants into the treatment groups.
30

31
32 207 The restorative treatment will be performed by four trained and calibrated
33
34 208 operators who will disclose which treatment they are performing at the
35
36 209 commencement of the restorative procedure. However, blinding participants and
37
38 210 operators will not be possible due to the evident differences between both techniques.
39

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41 211

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43 212 *Study groups*

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45 213 Participants will be randomly assigned into two different groups:

46
47 214 (a) Group I (control): composite resin restoration, using 37% phosphoric acid, Adper
48
49 215 Scotchbond Multipurpose adhesive system (3M/ESPE) and Filtek Z350 resin-
50
51 216 composite (3M/ESPE).
52

53
54 217 (b) Group II (experimental): ART using high-viscosity GIC Fuji IX (Gold Label – GC
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56 218 Corp) with manual dosage and hand-mixed powder and liquid.
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4
5 220 *Treatment protocol*

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7 221

8
9 222 (a) Composite resin restoration

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14 224 All children from Group I will be treated according to conventional techniques

15
16 225 using composite resin:

17
18 226 • Use local anesthesia;

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20
21 227 • Maintain absolute isolation of the operatory field with rubber dam and clamp;

22
23 228 • Remove caries: use hand excavators to remove caries in dentin. Both infected

24
25 229 and affected dentin should be removed from the dentin–enamel junction,

26
27 230 maintaining the affected dentin in the remaining dental walls. If necessary,

28
29 231 round bur at high speed under water cooling will be used to remove the

30
31 232 unsupported enamel;

32
33 233 • Etch enamel for 15 s and dentin for 7 s using 37% phosphoric acid, followed

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35 234 by rinsing for the same amount of time and drying with compressed air;

36
37 235 • Apply the Adper Scotchbond Multipurpose adhesive system (3M/ESPE)

38
39 236 according to the manufacturer's guidelines: primer application followed by

40
41 237 gentle drying for 5 s; then polymerization of the adhesive for 10 s with the XL

42
43 238 3000 curing light (3M/ESPE);

44
45 239 • Apply light-cured Filtek Z350 resin (3M/ESPE) using the oblique incremental

46
47 240 placement technique. Each increment should be polymerized for 20 s. In

48
49 241 occlusal-proximal cavities, an adapted matrix strip should be used with a

50
51 242 wooden wedge to maintain it in place, providing appropriate contour to the

52
53 243 restoration;

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3 244 • Remove the rubber dam and check the occlusion with articulating paper. If
4
5 245 necessary, finishing burs (F and FF) should be used under a cooling spray.
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7 246

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10 247 (b) Atraumatic Restorative Treatment (ART) using glass ionomer cement (GIC)
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14 249 All children from Group II will be treated according to the ART philosophy as
15
16 250 described by Frencken et al. (1996):[22]

- 17
18 251 • Maintain relative isolation of the operatory field with cotton rolls;
19
20
21 252 • Remove caries: using only hand excavators compatible with the size of the
22
23 253 carious cavity. Both infected and affected dentin should be removed from the
24
25 254 dentin–enamel junction. Thus, as described for Group I, the affected dentin
26
27 255 will be maintained in the remaining walls;
28
29
30 256 • Clean the cavity: cavity walls should be cleaned with cotton balls moistened
31
32 257 with water;
33
34 258 • Condition the dentin: apply a drop of 11.5% polyacrylic acid on a cotton ball
35
36 259 for 15 s. Then, wash the cavity with three cotton balls moistened with water
37
38 260 and dry using three more cotton balls;
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40
41 261 • Use correct dosage (one spoon measure of the powder to one drop of
42
43 262 polyacrylic acid): place the polyacrylic acid flask vertically and upside down,
44
45 263 wait a few seconds until the bubbles rise and then drip two drops. Use the first
46
47 264 drop to condition the cavity, because this initial drop may contain bubbles;
48
49
50 265 • Hand mix: spread the second drop of polyacrylic acid over the paper pad.
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52 266 Then, mix the powder in with the acid in two stages—manipulate the first part
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54 267 for 10 s and the second part for 15–20 s, applying moderate pressure. Use the
55
56 268 material only while it remains glossy;
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3 269 • Apply GIC: insert the GIC with a #1 spatula followed by finger pressure using
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5 270 petroleum jelly for a few seconds. For occlusal-proximal cavities, use an
6
7 271 adapted matrix strip with a wooden wedge to maintain it in place, providing
8
9
10 272 appropriate contour to the restoration. Protecting the restoration with
11
12 273 petroleum jelly is necessary to inhibit syneresis and imbibition;
- 14 274 • Check the occlusion: after the initial set (approximately 5 min), check the
15
16 275 occlusion with articulating paper. If necessary, sharp hand instruments should
17
18 276 be used for adjustments. A new layer of petroleum jelly should be applied to
19
20
21 277 the surface of the restoration;
- 23 278 • Instruct the patient not to eat solid food for 1 h.

25 279 Dental care other than restorative treatment related to this project will also be
26
27 280 provided in the dental care trailer by three operators trained in the same philosophy
28
29 281 regarding non-cavitated carious lesions [23] and pulp treatment [24]. Moreover, all
30
31 282 participants and their respective legal guardians will receive verbal instructions about
32
33 283 the use of toothpaste with a minimum concentration of 1000 ppm fluoride to prevent
34
35 284 dental caries.[25]

38 285 The risks related to the present research are similar to those found during
39
40 286 conventional clinical dental treatment. Thus, there is no Data Monitoring Committee.
41
42 287 Independent surveillance of trial data collection, management and analysis will be
43
44 288 undertaken by the principal investigator who has overall responsibility for the study
45
46
47 289 and is in charge of the data.

49 290

51 291 *Outcomes*

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3 293 The primary outcome will be the longevity of both restorative treatments after
4
5 294 follow-up for 2 years. Secondary outcomes will include the cost-efficacy of both
6
7 295 types of restorative treatment and self-reported discomfort.
8

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11 297 (I) Longevity

12
13
14 298 Treatment longevity will be evaluated after 6, 12, 18 and 24 months by two
15
16 299 trained examiners. The intra-examiner and inter-examiner concordances will be
17
18 300 calculated using Cohen's Kappa test. Only scores above 0.7 will be accepted. After
19
20 301 prophylaxis, the occlusal restorations will be clinically evaluated according to the
21
22 302 Frencken and Holmgren[26] criteria (Attachment B).

23
24
25 303 For occlusal-proximal restorations, the adopted criteria are those proposed by
26
27 304 Roeleveld et al.[27] (Attachment C). The width and depth of marginal defects, the
28
29 305 surface wear and the excess or lack of material will be measured using the WHO CPI
30
31 306 periodontal probe, which has a ball-shaped tip 0.5 mm in diameter.

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34 307 If any treatment need is noted at the return visits, the procedure will be
35
36 308 performed by one of the three trained operators until the case is resolved. Oral
37
38 309 hygiene and fluoride use instructions will be repeated at each return visit for all
39
40 310 children.

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42
43 311 Data from each participant will be registered in clinical records for future
44
45 312 statistical analysis. Data quality will be ensured by validation checks that include
46
47 313 missing data, out of range values, and illogical and invalid responses. All data entered
48
49 314 will be audited by the coordinator, and data queries will be raised as necessary.

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53 316 (II) Cost-efficacy

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3 317 The direct cost analysis will be based on previous publications[28, 29]
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5 318 adjusted to the Brazilian reality[30]. Both the professional cost and the procedure cost
6
7 319 will be considered (Figure 2).
8

9
10 320 To calculate the professional cost, we will use the previous calculation of
11
12 321 Floriano et al.[31], such that the time spent in each session will be converted to hours
13
14 322 and multiplied by the average income of a dentist per hour (\$13.89) and a dental
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16 323 assistant per hour (\$7.06) as ruled by the Brazilian federal law n° 3999/61.[30, 31] To
17
18 324 estimate the procedure cost, we will consider both the variable cost, which includes
19
20 325 electricity and the depreciation of instruments and equipment, and the materials
21
22 326 cost.[28, 32] To calculate the instruments and equipment depreciation (peripherals
23
24 327 and dental chair), we will use the previous calculation of Da Mata et al.[18] and
25
26 328 Floriano et al.[29] that considers their cost, a lifespan of 3 years for instruments[18]
27
28 329 and 5 years for equipment[30] and a monthly use of 160 h.
29
30

31
32 330 A researcher other than the operator will time each restorative treatment
33
34 331 session, including the return visits, and will register in predetermined sheets the
35
36 332 specifications and quantity of all materials used. Prices will be inferred from the
37
38 333 market value converted to US dollars and obtained by averaging the values from
39
40 334 different places that have commercialized the products used. The prices will also be
41
42 335 updated during the course of the study.
43
44

45 336 In order to estimate the cost-efficacy, the incremental cost-efficacy ratio
46
47 337 (ICER) will be estimated by dividing the average total cost by the survival after 2
48
49 338 years of each treatment:
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52 339
$$\text{ICER} = (\text{cost}_{\text{ART}} - \text{efficacy}_{\text{ART}}) / (\text{cost}_{\text{CT}} - \text{efficacy}_{\text{CT}})$$

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56 341 (III) Child self-reported discomfort
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3 342 The self-reported discomfort of each child will be evaluated using the Wong-
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5 343 Baker Facial Scale.[33] This scale indicates the discomfort of an individual who has
6
7 344 to choose among six faces, each one expressing different facial expressions. The first
8
9 345 image is a smiling happy face, followed by gradually less cheerful expressions up to
10
11 346 the last one, which is a very sad face covered in tears. The scale will be applied
12
13 347 immediately after each restorative treatment session by the operator who is timing the
14
15 348 procedure.

16
17
18 349 The participant will be asked to choose the face that best match how he or she
19
20 350 felt during the treatment. This answer should be given solely by the child, with no
21
22 351 parental or professional interference.[34]

23
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25 352

26
27 353 *Data analysis*

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29 354 To compare the longevity of the restorations, both Kaplan–Meier survival
30
31 355 analysis and Cox regression with shared frailty will be applied. The association
32
33 356 between restoration longevity and caries experience or the type of cavity will also be
34
35 357 evaluated using Cox’s Regression with shared frailty. To determine the data
36
37 358 normality, the Kolmogorov–Smirnov test will be used. In relation to the secondary
38
39 359 outcomes, the comparison between groups in relation to the time spent in each
40
41 360 procedure as well as the average cost of a restoration will be done through the use of
42
43 361 linear regression adjusted to the cluster effect. Multilevel Poisson regression will be
44
45 362 used to compare both groups and the other independent variables to the self-reported
46
47 363 discomfort. The significance level will be adjusted to 5%.

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51
52 365 **Ethics and dissemination**

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3 366 This clinical trial was approved by the Ethics Committee of Research in
4
5 367 Humans from the Faculty of Dentistry of the University of Sao Paulo (registration
6
7 368 #1.556.018). Participants will be included after their parents or legal guardians have
8
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10 369 signed an informed consent form containing detailed information about the research.

11 370 This study will involve the publication of grouped data collected from
12
13
14 371 participants' individual information. This statement will be described in the consent
15
16 372 form of each participant.
17

18
19 373

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21
22
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24
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26

27 377

28 29 378 **Authors' contributions**

30
31
32 379 DPR, MMB, FMM and IF contributed to the conception of this trial. DPR was
33
34 380 responsible for its design. DPR is the principal investigator and NML is trial
35
36 381 coordinator. DPR, NML and IO drafted the protocol. IF is in charge of the recruitment
37
38 382 of participants. NML is responsible for the patients' treatment. CSS and LY are
39
40 383 responsible for timekeeping, recording materials and organizing treatment. TKT is
41
42 384 responsible for patient evaluations over time. All authors critically reviewed and
43
44 385 approved the final manuscript as submitted.
45

46 386

47 48 49 387 **Competing interests**

50
51
52 388 We declare that there are no conflicts of interest regarding the performance of this
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54 389 trial.
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1
2
3 391 **Acknowledgments**
4

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6
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8
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10
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12
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18 398 **References**
19

- 20 399 1. Dhar V, Hsu KL, Coll JA, Ginsberg E, Ball BM et al. Evidence-based update
21
22 400 of pediatric dental restoration procedures: dental materials. *Journal of Clinical*
23
24 401 *Pediatric Dentistry* 2015; 39(4): 303-10.
25
26
27 402 2. Casagrande L, Dalpian DM, Ardenghi TM, Zanatta FB, Balbinot CEA et al.
28
29 403 Randomized clinical trial of adhesive restorations in primary molars. 18-
30
31 404 month results. *American Journal of Dentistry* 2013; 26 (6): 351-55.
32
33
34 405 3. Yengopal V, Harnekar SY, Patel N, Siegfried N. Dental filling for the
35
36 406 treatment of caries in the primary dentition. *Cochrane Database of Systematic*
37
38 407 *Reviews*. 2009; doi: 10.1002/14651858.
39
40
41 408 4. Mickenautsch S, Yengopal V, Banerjee A. Atraumatic restorative treatment
42
43 409 versus amalgam restoration longevity: A systematic review. *Clinical Oral*
44
45 410 *Investigations* 2010; 14: 233-240.
46
47
48 411 5. Raggio DP, Hesse D, Lenzi TL, Guglielmi CAB, Braga MM. Is atraumatic
49
50 412 restorative treatment an option for restoring occlusoproximal caries lesions in
51
52 413 primary teeth? A systematic review and meta-analysis. *International Journal of*
53
54 414 *Paediatric Dentistry* 2012; 23: 435-43.
55
56 415 6. Qvist V, Poulsen A, Teglers PT, Mjör IA. The longevity of different
57
58
59
60

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2
3 416 restorations in primary teeth. *International Journal of Paediatric Dentistry*
4
5 417 2010; 20: 1–7.
6
7 418 7. Heintze SD, Rousson V. Clinical effectiveness of direct Class II restoration: a
8
9 419 meta-analysis. *The Journal of Adhesive Dentistry* 2012; 14(5): 407-31.
10
11 420 8. Schriks MC, van Amerongen WE. Atraumatic perspectives of ART:
12
13 421 psychological and physiological aspects of treatment with and without rotary
14
15 422 instruments. *Community Dentistry and Oral Epidemiology* 2003; 31: 15–20.
16
17 423 9. Frencken JE, Pilot T, Songpaisan Y, Phantumvait P. Atraumatic restorative
18
19 424 treatment (ART): Rationale, technique, and development. *Journal of Public*
20
21 425 *Health Dentistry*. 1996; 56(3): 135-140.
22
23 426 10. Frencken JE. The State-of-Art of ART restorations. *Dental Update* 2014;
24
25 427 41(3):218-20.
26
27 428 11. van't Hof MA, Frencken JE, Van Palenstein Helderma WH, Holmgren WH.
28
29 429 The atraumatic restorative treatment (ART) approach for managing dental
30
31 430 caries: a meta-analysis. *International Dental Journal* 2006; 56(6): 345-51.
32
33 431 12. van Dijken JWV, Pallesen U. Long-term dentin retention of etch-and-rinse
34
35 432 and self-etch adhesives and a resin-modified glass ionomer cement in non-
36
37 433 carious cervical lesion. *Dental Materials* 2008; 24: 915–22.
38
39 434 13. Fuks AB, Araujo FB, Osorio LB, Hadami PE, Pinto AS. Clinical and
40
41 435 radiographic assessment of class II esthetic restorations in primary molars.
42
43 436 *Journal of Pediatric Dentistry* 2000; 22(5): 479-85.
44
45 437 14. Ersin NK, Candan U, Aykut A, Oncag O, Eronat C, Kose T. A clinical
46
47 438 evaluation of resin-based composite and glass-ionomer cement restorations
48
49 439 placed in primary teeth using the ART approach. *Journal of the American*
50
51 440 *Dental Association* 2006; 137: 1529-36.
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3 441 15. Alves dos Santos MP, Luiz RR, Maia LC. Randomized trial of resin-based
4
5 442 restorations in class I and class II beveled preparations in primary molars: 48-
6
7 443 month results. *Journal of Dentistry*. 2010; 38(6): 451-59.
8
9
10 444 16. Novaes TF, Matos R, Raggio DP, Braga MM, Mendes FM. Children's
11
12 445 discomfort in assessments using different methods for approximal caries
13
14 446 detection. *Braz. Oral Res*. 2012; 26(2): 93-99.
15
16 447 17. Staman NM, Townsend JA, Hagan JL. Observational study: discomfort
17
18 448 following dental procedures for children. *Pediatr. Dent*. 2013; 35(1): 52-4.
19
20
21 449 18. Da Mata C, Allen PF, Cronin M, O'Mahony D, McKenna G, Woods N.
22
23 450 Cost-effectiveness of ART restorations in elderly adults: a randomized clinical
24
25 451 trial. *Community Dentistry and Oral Epidemiology* 2014; 42: 79-87.
26
27 452 19. Mickenautsch S, Munshi I, Grossman ES. Comparative cost of Art and
28
29 453 conventional treatment within a dental school clinic. *Journal of Minimum*
30
31 454 *Intervention in Dentistry*. 2009; 2(2): 135-145.
32
33
34 455 20. WHO (World Health Organization). *Oral health surveys: basic methods*. 3ed.
35
36 456 Geneva: World Health Organization; 1997. (20)
37
38 457 21. Brasil. Ministério da Saúde (MS). Projeto SB Brasil 2010: condições de saúde
39
40 458 bucal da população brasileira 2009-2010. Resultados principais. Brasília:
41
42 459 2012.
43
44 460 22. Frencken JE, Pilot T, Songpaisan Y, Phantumvanit P. Atraumatic restorative
45
46 461 treatment (ART): rationale, technique, and development. *Journal of Public*
47
48 462 *Health Dentistry*. 1996; 56(3): 135-140.
49
50
51 463 23. Gibson G, Jurasic MM, Wehler CJ, Jones JA. Supplemental fluoride use for
52
53 464 moderate and high caries risk adults: a systematic review. *Journal of Public*
54
55 465 *Health Dentistry* 2011;71(3):171-84.
56
57
58
59
60

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2
3 466 24. Cerqueira DF, Mello-Moura AC, Santos EM, Guedes-Pinto AC. Cytotoxicity,
4
5 467 histopathological, microbiological and clinical aspects of an endodontic
6
7 468 iodoform-based paste used in pediatric dentistry: a review. *Journal of Clinical*
8
9 469 *Pediatric Dentistry* 2008;32(2):105-10.
- 10
11 470 25. Walsh T, Worthington HV, Glenny AM, Appelbe P, Marinho VC, Shi X.
12
13 471 Fluoride toothpastes of different concentrations for preventing dental caries in
14
15 472 children and adolescents. *Cochrane Database Systematic Review* 2010; 20(1):
16
17 473 1-221
- 18
19 474 26. Frencken JE, Holmgren CF. Tratamento restaurador atraumático (ART) para a
20
21 475 cárie dentária. São Paulo: Santos. 2001.
- 22
23 476 27. Roeleveld AC, Van Amerongen WE, Mandari GJ. Influence of residual caries
24
25 477 and cervical gaps on the survival rate of Class II glass ionomer restorations.
26
27 478 *European Archives of Paediatric Dentistry* 2006; 7(2): 85-91.
- 28
29 479 28. Takanashi Y, Penrod JR, Lund JP, Feine JS. A cost comparison of mandibular
30
31 480 two-implant overdenture and conventional denture treatment. *International*
32
33 481 *Journal of Prosthodontics* 2004; 17: 181-86
- 34
35 482 29. Oscarson N, Kallestal C, Fjelddahl A, Lindholm L. Cost effectiveness of
36
37 483 different caries preventive measures in a high-risk population of Swedish
38
39 484 adolescents. *Community Dentistry and Oral Epidemiology* 2003; 31(3): 169-
40
41 485 178.
- 42
43 486 30. Floriano I, Gimenez R, Reyes A, Matos R, Mattos-Silveira, J, Mendes FM.;
44
45 487 Braga MM. Análise de custos de diferentes abordagens para avaliação de
46
47 488 lesões de cárie em dentes decíduos. *Brazilian Oral Research*. 2013; 27(1): 41-
48
49 489 9.
- 50
51 490 31. Morita MC, Haddad AE, Araújo ME. Perfil atual e tendências do cirurgião-

- 1
2
3 491 dentista brasileiro. Maringá: Dental Press Internacional. 2010.
4
5 492 32. Kawai Y, Murakami H, Takanashi Y, Lund JP, Feine JS. Efficient resource
6
7 493 use in simplified complete denture fabrication. Journal of Prosthodontics
8
9 494 2010; 19: 512-16.
10
11 495 33. Wong DL, Baker CM. Pain in children: comparison of assessment scales.
12
13 496 Pediatric Nursing. 1988; 14(1): 9-17.
14
15 497 34. Novaes TF, Matos R, Raggio DP, Imperato JC, Braga MM, Mendes FM.
16
17 498 Influence of the discomfort reported by children on the performance of
18
19 499 approximal caries detection methods. Caries Research. 2010; 44(5): 465-71.
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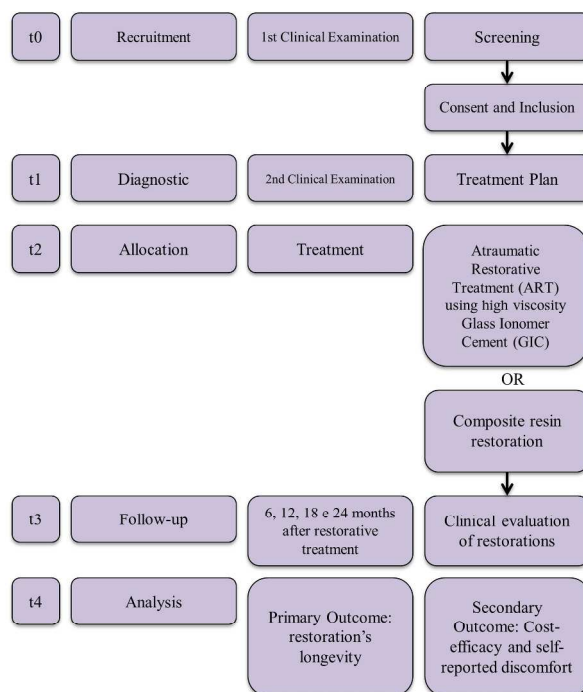


Figure 1: Clinical trial's timeline

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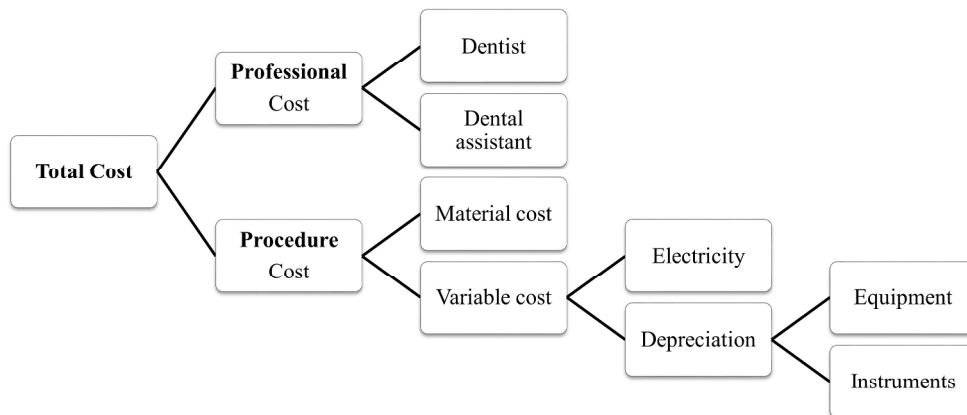


Figure 2: Diagram of total cost calculation

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STANDARD PROTOCOL ITEMS: RECOMMENDATIONS FOR INTERVENTIONAL TRIALS

SPIRIT 2013 Checklist: Recommended items to address in a clinical trial protocol and related documents*

Section/item	Item No	Description	Addressed on page number
Administrative information			
Title	1	Descriptive title identifying the study design, population, interventions, and, if applicable, trial acronym	01
Trial registration	2a	Trial identifier and registry name. If not yet registered, name of intended registry	04
	2b	All items from the World Health Organization Trial Registration Data Set	_____
Protocol version	3	Date and version identifier	04
Funding	4	Sources and types of financial, material, and other support	15
Roles and responsibilities	5a	Names, affiliations, and roles of protocol contributors	01, 02
	5b	Name and contact information for the trial sponsor	02
	5c	Role of study sponsor and funders, if any, in study design; collection, management, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication, including whether they will have ultimate authority over any of these activities	16
	5d	Composition, roles, and responsibilities of the coordinating centre, steering committee, endpoint adjudication committee, data management team, and other individuals or groups overseeing the trial, if applicable (see Item 21a for data monitoring committee)	_____

1 **Introduction**

2

3 Background and 6a Description of research question and justification for undertaking the trial, including summary of relevant 05
 4 rationale studies (published and unpublished) examining benefits and harms for each intervention

5

6 6b Explanation for choice of comparators 05

7

8 Objectives 7 Specific objectives or hypotheses 06

9

10 Trial design 8 Description of trial design including type of trial (eg, parallel group, crossover, factorial, single group),
 11 allocation ratio, and framework (eg, superiority, equivalence, noninferiority, exploratory) 06

12

13

14 **Methods: Participants, interventions, and outcomes**

15

16 Study setting 9 Description of study settings (eg, community clinic, academic hospital) and list of countries where data will 07
 17 be collected. Reference to where list of study sites can be obtained

18

19 Eligibility criteria 10 Inclusion and exclusion criteria for participants. If applicable, eligibility criteria for study centres and 07
 20 individuals who will perform the interventions (eg, surgeons, psychotherapists)

21

22 Interventions 11a Interventions for each group with sufficient detail to allow replication, including how and when they will be 09, 10, 11, 12
 23 administered

24

25 11b Criteria for discontinuing or modifying allocated interventions for a given trial participant (eg, drug dose _____
 26 change in response to harms, participant request, or improving/worsening disease)

27

28 11c Strategies to improve adherence to intervention protocols, and any procedures for monitoring adherence _____
 29 (eg, drug tablet return, laboratory tests)

30

31 11d Relevant concomitant care and interventions that are permitted or prohibited during the trial _____

32

33 Outcomes 12 Primary, secondary, and other outcomes, including the specific measurement variable (eg, systolic blood
 34 pressure), analysis metric (eg, change from baseline, final value, time to event), method of aggregation (eg, 12, 13, 14
 35 median, proportion), and time point for each outcome. Explanation of the clinical relevance of chosen
 36 efficacy and harm outcomes is strongly recommended

37

38 Participant timeline 13 Time schedule of enrolment, interventions (including any run-ins and washouts), assessments, and visits for 08
 39 participants. A schematic diagram is highly recommended (see Figure)

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1	Sample size	14	Estimated number of participants needed to achieve study objectives and how it was determined, including clinical and statistical assumptions supporting any sample size calculations	07
2				
3				
4	Recruitment	15	Strategies for achieving adequate participant enrolment to reach target sample size	08
5				
6				
7	Methods: Assignment of interventions (for controlled trials)			
8	Allocation:			
9				
10	Sequence	16a	Method of generating the allocation sequence (eg, computer-generated random numbers), and list of any factors for stratification. To reduce predictability of a random sequence, details of any planned restriction (eg, blocking) should be provided in a separate document that is unavailable to those who enrol participants or assign interventions	09
11	generation			
12				
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16	Allocation	16b	Mechanism of implementing the allocation sequence (eg, central telephone; sequentially numbered, opaque, sealed envelopes), describing any steps to conceal the sequence until interventions are assigned	09
17	concealment			
18	mechanism			
19				
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21	Implementation	16c	Who will generate the allocation sequence, who will enrol participants, and who will assign participants to interventions	08 e 09
22				
23				
24	Blinding (masking)	17a	Who will be blinded after assignment to interventions (eg, trial participants, care providers, outcome assessors, data analysts), and how	09
25				
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28		17b	If blinded, circumstances under which unblinding is permissible, and procedure for revealing a participant's allocated intervention during the trial	_____
29				
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32	Methods: Data collection, management, and analysis			
33				
34	Data collection	18a	Plans for assessment and collection of outcome, baseline, and other trial data, including any related processes to promote data quality (eg, duplicate measurements, training of assessors) and a description of study instruments (eg, questionnaires, laboratory tests) along with their reliability and validity, if known. Reference to where data collection forms can be found, if not in the protocol	12
35	methods			
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40		18b	Plans to promote participant retention and complete follow-up, including list of any outcome data to be collected for participants who discontinue or deviate from intervention protocols	_____
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1	Data management	19	Plans for data entry, coding, security, and storage, including any related processes to promote data quality (eg, double data entry; range checks for data values). Reference to where details of data management procedures can be found, if not in the protocol	06
2				
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4				
5	Statistical methods	20a	Statistical methods for analysing primary and secondary outcomes. Reference to where other details of the statistical analysis plan can be found, if not in the protocol	15
6				
7				
8		20b	Methods for any additional analyses (eg, subgroup and adjusted analyses)	15
9				
10		20c	Definition of analysis population relating to protocol non-adherence (eg, as randomised analysis), and any statistical methods to handle missing data (eg, multiple imputation)	_____
11				
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14	Methods: Monitoring			
15				
16	Data monitoring	21a	Composition of data monitoring committee (DMC); summary of its role and reporting structure; statement of whether it is independent from the sponsor and competing interests; and reference to where further details about its charter can be found, if not in the protocol. Alternatively, an explanation of why a DMC is not needed	12
17				
18		21b	Description of any interim analyses and stopping guidelines, including who will have access to these interim results and make the final decision to terminate the trial	_____
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25	Harms	22	Plans for collecting, assessing, reporting, and managing solicited and spontaneously reported adverse events and other unintended effects of trial interventions or trial conduct	06, 12
26				
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28				
29	Auditing	23	Frequency and procedures for auditing trial conduct, if any, and whether the process will be independent from investigators and the sponsor	12
30				
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32				
33	Ethics and dissemination			
34				
35	Research ethics approval	24	Plans for seeking research ethics committee/institutional review board (REC/IRB) approval	15
36				
37				
38	Protocol amendments	25	Plans for communicating important protocol modifications (eg, changes to eligibility criteria, outcomes, analyses) to relevant parties (eg, investigators, REC/IRBs, trial participants, trial registries, journals, regulators)	_____
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1	Consent or assent	26a	Who will obtain informed consent or assent from potential trial participants or authorised surrogates, and how (see Item 32)	07, 15
2				
3				
4		26b	Additional consent provisions for collection and use of participant data and biological specimens in ancillary studies, if applicable	_____
5				
6				
7	Confidentiality	27	How personal information about potential and enrolled participants will be collected, shared, and maintained in order to protect confidentiality before, during, and after the trial	06
8				
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10	Declaration of interests	28	Financial and other competing interests for principal investigators for the overall trial and each study site	16
11				
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13	Access to data	29	Statement of who will have access to the final trial dataset, and disclosure of contractual agreements that limit such access for investigators	06
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17	Ancillary and post-trial care	30	Provisions, if any, for ancillary and post-trial care, and for compensation to those who suffer harm from trial participation	06
18				
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20	Dissemination policy	31a	Plans for investigators and sponsor to communicate trial results to participants, healthcare professionals, the public, and other relevant groups (eg, via publication, reporting in results databases, or other data sharing arrangements), including any publication restrictions	06
21				
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25		31b	Authorship eligibility guidelines and any intended use of professional writers	_____
26				
27		31c	Plans, if any, for granting public access to the full protocol, participant-level dataset, and statistical code	_____
28				
29				
30	Appendices			
31				
32	Informed consent materials	32	Model consent form and other related documentation given to participants and authorised surrogates	_____
33				
34				
35	Biological specimens	33	Plans for collection, laboratory evaluation, and storage of biological specimens for genetic or molecular analysis in the current trial and for future use in ancillary studies, if applicable	_____
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37				

*It is strongly recommended that this checklist be read in conjunction with the SPIRIT 2013 Explanation & Elaboration for important clarification on the items. Amendments to the protocol should be tracked and dated. The SPIRIT checklist is copyrighted by the SPIRIT Group under the Creative Commons [“Attribution-NonCommercial-NoDerivs 3.0 Unported”](https://creativecommons.org/licenses/by-nc-nd/3.0/) license.

Attachment B – Assessment criteria by Frencken and Holmgren (2001)

Score	Criteria
0	Present, good
1	Present, slight marginal defect for whatever reason, at any one place, which is less than 0.5 mm in depth. No repair is needed
2	Present, marginal defect for whatever reason, at any one place which is deeper than 0.5 mm but less than 1.0 mm. Repair is needed
3	Present, gross defect of more than 1.0 mm in depth. Repair is needed
4	Not present, restoration has (almost) completely disappeared. Treatment is needed
5	Not present, other restorative treatment has been performed
6	Not present, tooth has been extracted
7	Present, wear and tear gradually over larger parts of the restoration but are less than 0.5 mm at the deepest point. No repair is needed
8	Present, wear and tear gradually over larger parts of the restoration which are deeper than 0.5 mm. Repair is needed
9	Unable to diagnose

Note: Restorations considered to have survived are scored by codes: 0, 1 and 7; those considered to have failed by codes: 2, 3, 4 and 8; while those that are considered to be unrelated to success and failure are coded: 5 and 6.

Attachment C – Assessment criteria by Roeleveld et al. (2006)

Score	Criteria
00	Restoration still present, correct
10	Restoration present, slight defect at the margin and/or wear of the surface; < 0.5 mm in depth, repair needed
11	Restoration present, defect at the margin and/or wear of the surface; > 0.5 mm in depth, repair needed
12	Restoration present; underfilled > 0.5 mm, no gap, repair needed
13	Restoration overfilled > 0.5 mm, repair needed
20	Secondary caries, discoloration in depth, surface hard and intact, caries within dentin; repair needed
21	Secondary caries. Surface defect, caries within dentin; repair needed
30	Restoration not present, bulk fracture, loose, (partly) lost; repair needed (if still possible without exposing the pulp)
40	Inflammation of the pulp (restoration still in situ, not categorized in the former categories); fistula or severe pain complaints; extraction needed
50	Tooth not present because of extraction
60	Tooth not present because of shedding
70	Tooth not present because of extraction
90	Patient not present

Note: Restorations considered to have survived are scored by codes: 00 and 10; those considered to have by code: 11, 12, 13, 20, 21, 30 or 40; while those considered to be unrelated to success and failure are coded: 50, 60, 70 or 90