

Influence of rubber dam on objective and subjective parameters of stress during dental treatment of children and adolescents – a randomized controlled clinical pilot study

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Background. Rubber dam is recommended for isolating the working field during adhesive dentistry procedures; however, dentists often omit rubber dam, particularly in paediatric dentistry, supposing that it would stress the patient.

Aim. The aim of this study was to evaluate stress parameters during a standardized dental treatment procedure performed with or without rubber dam. The treatment time was measured as a secondary outcome variable.

Design. This study was designed as a randomized, controlled, clinical study with 72 patients (6–16 years; mean age, 11.1). During standardized fissure sealing procedures, objective parameters

of stress (e.g., skin resistance, breath rate) were recorded. The operator's stress level was measured by pulse rate. Subjective pain (patients) and stress perception (operator) were evaluated by an interview.

Results. The breath rate was significantly ($P < 0.05$) lower and the skin resistance level was significantly higher during treatment with rubber dam compared to the control group. Subjective pain perception was significantly lower for the test group. The treatment time needed for the fissure sealing procedure was 12.4% less in the test group.

Conclusion. Isolation with rubber dam caused less stress in children and adolescents compared to relative isolation with cotton rolls if applied by an experienced dentist.

Introduction

When using modern adhesive techniques, a proper isolation of the working field is an important precondition to guarantee the restoration's long-term survival; however, studies show that, with respect to the quality of a filling or fissure sealing, the use of rubber dam does not necessarily lead to significantly better results^{1–5}. One study reported significantly better retention rates of fissure sealants after 1 year when using rubber dam compared to relative isolation⁶. Besides isolation, several additional advantages for the use of rubber dam have been reported in the literature: protection from aspiration, a clearly arranged working field, protection of the soft tissue, and reduction of infectious pathogens

in the aerosol^{7,8}. According to other authors, patients get the impression that the treatment takes place outside of their mouth, so that even children tolerate longer treatments once the rubber dam has been applied^{9,10}. Time savings, if used by experienced persons, have also been reported, mainly because soft tissue management and changing of cotton rolls can be omitted¹¹. Interestingly, Brandstetter *et al.*¹² observed reduced heart and circulation parameters in dentists working with rubber dam and interpreted their findings as relaxation.

The aim of this randomized, controlled, clinical study was to evaluate subjective and objective stress parameters in children and adolescents during dental treatment when using rubber dam compared to relative isolation with cotton rolls and saliva ejector. The null hypothesis was that there is no difference in stress parameters between the test and the control group. Additionally, the treatment time was measured as a secondary outcome variable.

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Materials and methods

Examinations and treatments were performed in a German private practice in Heide (Holstein), Germany. Children and adolescents, specifically their parents, were asked during check-up visits to participate in this study, as long as the inclusion criteria (aged between 6 and 16 years, given indication for fissure sealing) were fulfilled and no exclusion criteria were met. Exclusion criteria were participation in other studies evaluating parameters of stress, not totally erupted teeth to seal, lack of compliance, no agreement from the parents, fixed orthodontic appliances, signs of opacity and brown discoloration after cleaning the surface of the tooth to be sealed, psychotropic medication or cardiovascular drugs, already sealed teeth, present disease (cold), and allergic reactions to used materials.

In total, 72 subjects successfully took part in the study and were divided into two parallel groups by a dental assistant by drawing sealed lots (test $n = 34$, control $n = 38$). The study (#EA2/081/08) was approved by the ethics committee of the University Clinic Charité (Berlin, Germany) in accordance with the ethical principles of the Declaration of Helsinki. All participants agreed and their parents signed a written consent form. In the test group, the fissure sealants were placed under rubber dam (Premium Rubber Dam Pure Latex®; Heraeus Kulzer, Hanau, Germany). In the control group, the isolation was achieved using cotton rolls and saliva ejector (Roeko, Coltène Whaledent, Altstätten, Switzerland). The subject's parameters of stress (pulse rate, breath rate, skin resistance, blood pressure) were recorded at five measuring points (Table 1). For the operator, only the pulse rate was measured (Table 1). The patient's subjective pain perception during treatment was recorded with a questionnaire after the treatment using a visual analogue scale (1–10). A questionnaire about subjective mental and physical stress (scale: 1 = extremely easy to 7 = extremely stressful) was completed by the operator after treatment.

Depending on the age, caries-free molars and/or premolars of the mandible were sealed (age 6–8, molars; age 10–16, premolars).

Table 1. Definition of measuring points and measured parameters.

| Measuring point | Treatment phase | Measured parameters | |
|-----------------|--|---------------------|----------|
| | | Patient | Operator |
| 0 | Baseline values after a waiting time of at least 10 min in the waiting or treatment room | BP, PR | PR |
| 1 | After sitting in the treatment chair and applying the measuring equipment before treatment starts | PR, BR, SR | PR |
| 2 | After light curing of the sealant on the left side before removing the rubber dam or cotton rolls | PR, BR, SR | PR |
| 3 | After light curing of the sealant on the right side before removing the rubber dam or cotton rolls | PR, BR, SR | PR |
| 4 | After treatment before removing the measuring equipment | PR, BR, SR, BP | PR |

BP: blood pressure (sphygmomanometer applied to forearm, Visomat® III E, device number 3040303160, Uebe GmbH, Wertheim, Germany).

PR: pulse rate (photoelectric measurement on patient's earlobe, SOM biofeedback apparatus, device number 80604, SOM Gerätebau GmbH, Murrhardt, Germany, or running computer applied to practitioner, POLAR RS 400, SD running computer, device number C725K00747717, Polar Elektro Oy, Kempele, Finland).

BR: breath rate (breath measurement device [belt], SOM biofeedback apparatus as above).

SR: skin resistance (SRR and SRL, adhesive electrodes applied to ring finger and index finger, SOM biofeedback apparatus as above).

Before sealing, the teeth were cleaned with a prophylaxis paste (Nupro 200®; Dentsply DeTrey, Konstanz, Germany) for 30 s. After rinsing with water spray, the tooth was dried with air for 5 s followed by an evaluation of the fissures using the clinical diagnostic criteria of Ekstrand *et al.*¹³. Only teeth with no occlusal changes at the time of sealing were included, which corresponds to value 0 according to Ekstrand *et al.*¹³. The treatment always started in the third quadrant. In the control group, the cotton rolls were positioned on the buccal and lingual region of the tooth to be sealed and were fixed by the operator's index finger and middle finger. Additionally, a saliva ejector

was placed on the lingual side. For the rubber dam isolation, a suitable rubber dam clamp (Ivory[®]; Sigma Dental Systems, Handewitt, Germany) was selected and applied. Afterwards, the rubber dam was placed over the clamp. Several teeth were included in the rubber dam in cases involving premolars, whereas for molars only the treated tooth was isolated. After cleaning, rinsing, and drying, the teeth were etched using 35% phosphoric acid gel (Conditioner 36[®]; Dentsply DeTrey) for 60 s and rinsed for at least 20 s. The cotton rolls were renewed in the corresponding group without contaminating the tooth with saliva. The drying with air lasted for 20 s. The fissure sealant (Delton[®] opaque; Dentsply DeTrey) was applied with the appropriate application system and spread out with a ball plugger. Excess material was removed with pellets. The sealant was cured with light (Bluephase[®]; Ivoclar Vivadent, Schaan, Liechtenstein) for 20 s. After removing the rubber dam or cotton rolls, respectively, the occlusion was checked and a fluoride varnish (Duraphat[®]; Colgate-Palmolive, Hamburg, Germany) was applied.

Statistical analysis

For the comparison of the mean values between groups at different measuring points, the *t*-test with Bonferroni correction was used. The level for statistical significance was set at $P < 0.05$. In terms of statistical power, this study was handled as a pilot study owing to the lack of comparable studies in children.

Results

Subjects

A total of 72 children (49 girls, 23 boys) aged between 5.9 and 16.9 years (mean age, 11.1 years) participated in this study. Two of all asked potential participants refused to take part in the study. All 72 treatments were finished accordingly, and all the planned rubber dam placements were possible. No patient had to be excluded after given agreement. Sealants were applied to 234 teeth in the mandible (54 molars and 180 premolars).

A total of 24 molars and 88 premolars were treated using rubber dam for isolation, and 30 molars and 92 premolars using cotton rolls for isolation. The educational background as well as other baseline parameters in this study showed no statistically significant difference ($P > 0.05$) between the test and the control group (Table 2).

Subjective pain perception of the children

Significantly higher ($P < 0.05$) subjective perception of pain during treatment was found for the control group at measuring points 2 and 3 (Fig. 1).

Objective stress parameters of children during treatment

The breath rate was slightly higher in the control group compared to the test group and was statistically significantly higher at point 2 (Fig. 2).

The pulse rate of the control group was slightly higher than the test group immediately after application of the measuring apparatus (Point 1, Fig. 3) but did not reach statistical significance.

For the skin resistance response (SRR), no significant difference could be detected, whereas for the skin resistance level (SRL), significantly higher values could be detected for the test group at measuring points 3 and 4 (Fig. 4).

No significant differences could be detected for blood pressure (data not shown).

Table 2. Baseline data of gender, age, and type of teeth.

| Patients (n = 72) | Test group (n = 34) | Control group (n = 38) |
|-----------------------|---|---|
| Gender | Male: 9 (26%) Female: 25 (74%) | Male: 14 (37%) Female: 24 (63%) |
| Age (yrs) | 11.5 ± 3.2 | 10.8 ± 2.9 |
| Type of teeth treated | Patients with mandibular premolars treated: 22 (65%) Patients with mandibular molars treated: 12 (35%) | Patients with mandibular premolars treated: 23 (61%) Patients with mandibular molars treated: 15 (39%) |

No significant differences in these parameters were detected ($P > 0.05$).

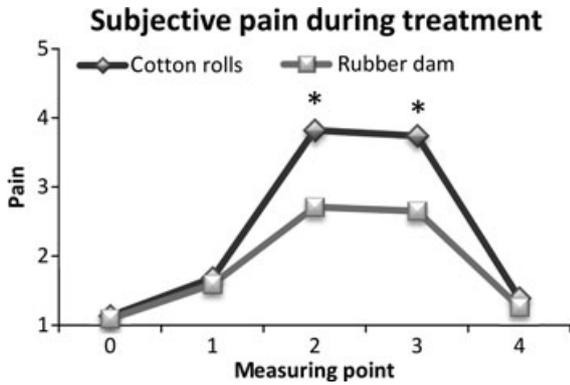


Fig. 1. Patient's subjective pain perception (1 = no pain and 10 = strong pain) (* $P < 0.05$). See Table 1 for explanation of measuring points.

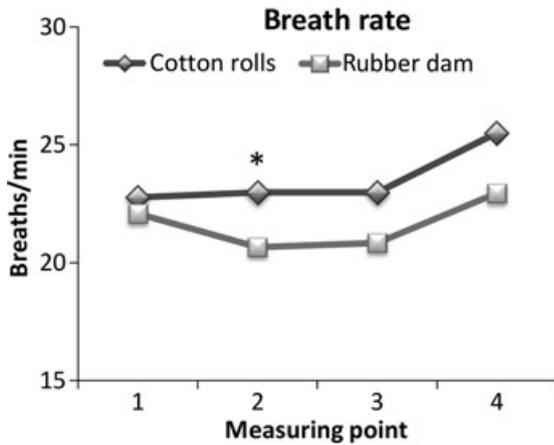


Fig. 2. Patient's breath rate (* $P < 0.05$).

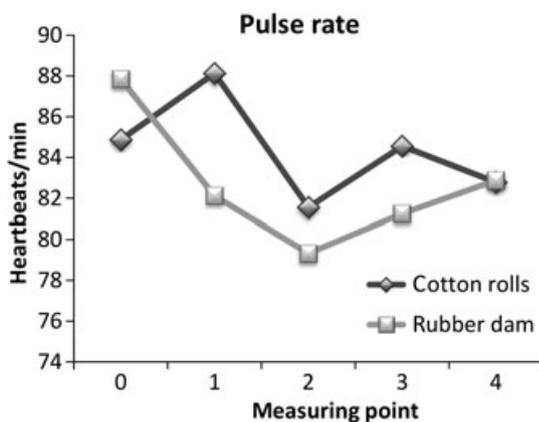


Fig. 3. Patient's pulse rate.

Operator's perception and pulse rate

The pulse rate of the operator was significantly lower when using rubber dam at measuring points 2–4 (Fig. 5).

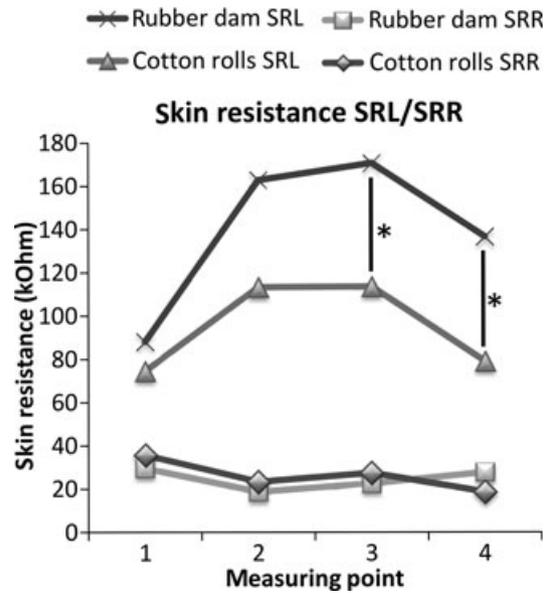


Fig. 4. Patient's skin resistance level and skin resistance response (* $P < 0.05$).

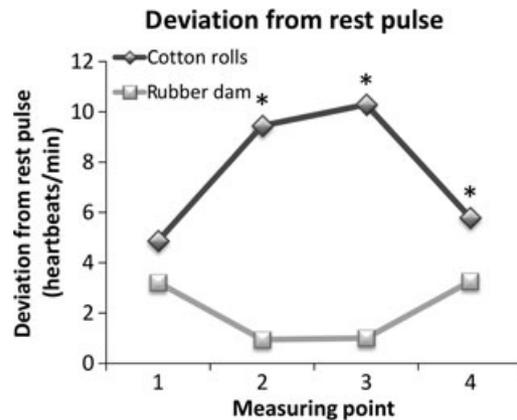


Fig. 5. Deviation from operator's rest pulse (* $P < 0.05$).

The self-perceived mental and physical stress reported by the operator was also significantly lower when using rubber dam as the isolation method (mean values of 3.71 [mental] and 3.66 [physical] for the control treatment, and 2.88 [mental] and 2.35 [physical] for the test treatment).

Treatment time

The time needed to finish the fissure sealing treatment was 12.4% (108 s) less when using rubber dam ($P < 0.05$).

Discussion

To the present authors' knowledge, this is the first report on a clinical trial measuring subjective and objective stress parameters in patients in conjunction with rubber dam application during standardized dental treatment. The fissure sealing procedure was chosen for this trial to induce a balanced and relatively low stress level in both groups. Other operative treatments in paediatric dentistry, such as adhesive filling procedures, can be considered more difficult to standardize and would have caused a wider variety of stress levels overlaying the stress caused by the isolation technique.

The questionnaire, completed immediately after the treatment, showed that patients had a significantly lower pain perception if rubber dam was used (Fig. 1). Therefore, potential pain and discomfort is not substantiated as a legitimate argument to refuse the use of rubber dam. It has to be considered that in the current study, most patients were teenagers and not young children. The subjective view of the children was supported by the objective biosignals collected during treatment. Breath rate, pulse rate, blood pressure, and skin resistance have been reported to be biosignals related to stress^{14–16}.

The significantly lower breath rate at measuring point 2, the tendency for a lower pulse rate, and the significantly higher rates in the skin resistance level during the treatment with rubber dam can be interpreted as signs of a higher degree of relaxation during treatment¹⁷. The skin resistance response changes quickly and reacts to a sudden stimulus, whereas the skin resistance level increases slowly if the sympathetic nervous system is inhibited (corresponding to relaxation). A possible explanation for the lower stress levels detected in the test group might be that rubber dam – once in place – separates the operative field in a way that the patient perceives the treatment procedure being performed outside of his/her body^{9,10}, whereas the manipulation of cotton rolls takes place on the inside. It has to be considered that the operator during this trial (A. K.) has substantial experience using rubber dam, however,

Monitoring his pulse rate during the trial allows the interpretation that the treatment procedure with rubber dam was less stressful for him than using cotton rolls. His mental state might have influenced the children during the trial because the stress level of the dentist might be transferred to the patient. This explanation is supported by other studies showing that the acceptance of rubber dam is higher when being applied by an experienced dentist^{11,18}. It is, however, most likely that both factors contribute to a certain extent, but the level of contribution cannot be determined based on the current study design. Thus, conclusions from this study have to be drawn carefully because it was not possible to blind the operator with regard to the treatment (with or without rubber dam) and his personal preference for rubber dam is certainly a bias for the outcome of this study. In future studies, operators with different rubber dam experience levels should be included to resolve this problem. Further studies should also consider the inclusion of validated anxiety measurement scales such as the CFSS-DS to examine dental anxiety in both groups¹⁹. A *post hoc* power analysis (α -level, 0.05; power, 0.8) was undertaken for significant and meaningful variables. Using an outcome difference of 2/min for the breath rate and 50 kOhm for the skin resistance level, a required sample size per group depending on the measuring point of 47–135 (breath rate) and of 42–195 (skin resistance level) was found.

In summary, this study reveals that in the hands of an experienced dentist, isolation with rubber dam is less stressful for children and adolescents than isolation with cotton rolls and can save valuable treatment time.

Why this paper is important to paediatric dentists

- This study shows that, in the hands of an experienced dentist, dental treatment is less stressful for children and adolescents when rubber dam is used as an isolation technique.
- Paediatric dentists should be encouraged to improve their rubber dam application skills to provide a less stressful treatment to their patients.
- The current study confirmed earlier findings that comparable treatment procedures need less chairtime when rubber dam is used as an isolation method.

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Conflict of interest

The authors declare no conflict of interest.

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