Comfort and discomfort of dental trauma splints — a comparison of a new device (TTS) with three commonly used splinting techniques


Abstract — The present experimental study compared four dental trauma splints in 10 volunteers. The evaluated splints included a wire-composite splint (WCS), a button-bracket splint (BS), a resin splint (RS), and the newly developed titanium trauma splint (TTS). All splints were bonded to the labial surfaces of the maxillary lateral and central incisors and left in place for 1 week. After splint removal, the next splint was placed after a 1-week rest period. The sequence of splint application was randomized for each individual. The following subjective parameters were assessed using a visual analogue scale: sensitiveness of splinted teeth, irritation of the gingival margin, irritation of the lips, impairment of speech, eating and oral hygiene. The results show that the application of BS leads to a significantly higher irritation of the lips and greater impairment of speech compared to other splints (P < 0.05). The RS leads to an increased and significantly higher irritation of the gingiva (P < 0.05) owing to a significant increase in cleaning difficulties (P < 0.05). In conclusion, WCS and TTS appear to be more accepted splints according to a subjective assessment by 10 volunteers.

Commonly used splinting techniques have been investigated in vitro and in vivo (9–13). In a recent study, parameters such as tooth mobility (Periotest values), probing depths, plaque accumulation, bleeding on probing and the chair time needed for splint application and removal were evaluated. The investigated splinting methods included the wire-composite splint (WCS), the button-bracket splint (BS), the resin splint (RS) and the new titanium trauma splint (TTS) (14). It could be shown that all four tested splints maintained normal tooth mobility: TTS and WCS allowed a more physiologic and RS a critically reduced tooth mobility (horizontal Periotest values). Periodontal parameters remained unchanged, reflecting
the excellent oral hygiene by the study subjects. The chair time used for fixation and removal was significantly lower for TTS.

From the patient’s perspective, it is important that these splints are comfortable and do not interfere with oral hygiene, speaking and eating. In addition, the splints should not irritate adjacent tissues (gingiva, lips). The objective of this experimental study was to compare and evaluate TTS, WCS, RS and BS with respect to the subjective assessment by the patient.

Materials and methods
The study was conducted in 10 volunteers recruited from the staff of the Department of Oral Surgery and Stomatology, University of Berne. All subjects were female with a mean age of 21 years and 6 months (range 17 years and 6 months to 34 years and 9 months). The study design was approved by the Ethical Commission of the Canton Berne (study-number: ZMK-OCI/2000) and the clinical study was carried out according to the Helsinki declaration. The same study design has been used in a previous paper analysing different clinical parameters, such as tooth mobility, periodontal status, working time (9). All four maxillary incisors in all volunteers were free of caries and periodontal diseases. All subjects were healthy and presented no medical contraindications for the planned procedures.

Four different splinting methods were evaluated in each individual, resulting in a total of 40 splints. The sequence of splint application was determined at random. Each splint was left in situ for 7 days. After removal, the next splint was placed after waiting for at least 1 week.

All splints were bonded to the labial aspect of all maxillary incisors. By placing the splints coronally, they were kept away from the gingival margin and the papillae. After drying the teeth, etching of the enamel surface was performed with 35% phosphoric acid gel for 30 s. Subsequently, the gel was rinsed off with water and the etched surfaces were dried again. A thin layer of bonding agent was applied. After polymerization, the splints were placed with the techniques described below.

**Titanium trauma splint (TTS)**
After cutting to the desired length, the TTS was bent to the labial aspects of the incisors. Per tooth, one rhombus of the TTS was filled with light-curing composite (Tetric Flow Chroma, Vivadent, Schaan, Liechtenstein) (Fig. 1) with 30 s of polymerization.

**Wire-composite splint (WCS)**
An 0.16 in. × 0.22 in. orthodontic wire was cut to the desired length, adapted to the curvature of the incisors using a plier and secured with identical composite (Fig. 2).

**Button-bracket splint (BS)**
Button brackets for direct bonding (Dentaurum, Ispringen, Germany) were bonded with the same composite. Thereafter, a 0.3-mm soft wire (Remanium®, Dentaurum, Ispringen, Germany) was braided from button to button to connect the four incisors. Finally, the wire was secured to each button with composite (Fig. 3).

**Resin splint (RS)**
The resin (Protemp II, ESPE Dental, Seefeld, Germany) was mixed according to the manufacturer’s instructions. Using a syringe, resin was continuously applied to the labial crown aspects connecting all incisors (Fig. 4).

The subjective study parameters were the following: sensitiveness of splinted teeth, irritation of gingival margin, irritation of the lips, impairment of speech,
eating and oral hygiene. All study parameters were recorded daily by each volunteer for each splint following splint application. They were given a special form with a visual analogue scale (v.a.s.) (length 10 cm) for each parameter per day. After completion of the study, the length of the markings on the v.a.s. was measured in millimetres.

The statistical evaluation was performed at days 1, 4 and 7 to register not only the immediate effects of the splints, but also a possible subsequent adaptation by the volunteers. All data were analysed by descriptive methods using box plots. As they were not normally distributed, the Wilcoxon test for paired data was performed. When employing multiple comparisons, the P-values were corrected using the Bonferroni adjustment procedure (Systat 5.2, Systat Inc., Evanston, IL, USA). The significant level chosen in all statistical tests was 0.05.

Results

None of the subjects withdrew from the study; a total of 40 splints could, therefore, be evaluated.

The parameters ‘impairment of eating’ and ‘irritation of gingival margin’ showed no statistical differences between the four splints. However, RS showed an increasing irritation of the gingiva over time compared to the other splints (day 1 vs. days 4 and 7, \( P < 0.05 \)) (Fig. 5). Sensitiveness of teeth and lips was more severe for most splints on day 1, with a continuous recovery on the following days (Figs. 6 and 7). Statistically significant differences of sensitive teeth on day 1 were found for BS compared to WCS \( (P < 0.05) \) and of sensitive lips for BS compared to WCS and RS \( (P < 0.05) \). At days 4 and 7, no statisti-
cally significant differences were found. Regarding impairment of speech, significant differences were found on day 1 for BS compared to all other splints ($P < 0.05$) (Fig. 8). The oral hygiene of the splinted maxillary incisors was significantly impaired by RS compared to the other splints throughout the splinting period ($P < 0.05$) (Fig. 9).

Discussion

In addition to clinical parameters such as stability, physiologic mobility of splinted teeth as well as ease of use, splints in dental traumatology should not interfere with the patient’s comfort. However, most of the splints currently used for treatment of traumatized teeth result in some discomfort during the initial period. Any mechanical or inflammatory irritation of the healing soft tissues must be avoided. Maintenance of oral hygiene is essential for healing following dental trauma (15). Plaque accumulation is detrimental to the periodontal healing of traumatized teeth (16, 17). The presented results clearly show that BS as well as RS leads to more irritation. Compared to the three other splints, RS is difficult to clean and therefore leads to greater irritation of the gingival margin (see Figs. 5 and 9). BS is rather voluminous and irritates mechanically, and therefore leads to clearly higher sensiveness of lips and impairment of speech compared to the other splints, particularly on day 1 following splint placement (see Figs. 7 and 8). However, TTS or WCS were much less irritating and were well tolerated by the volunteers.

The presented study only includes the subjective findings of the volunteers. The clinical comparison
of these four splints was reported previously (9). All tested splints fulfil the current requirements of a dental trauma splint, such as direct intra-oral application, using everyday dental materials such as wires, brackets, composite and resin. All these splints stabilize traumatized teeth in the original position and bring about adequate fixation and physiologic mobility for the entire immobilization period (4, 9).

In conclusion, and with consideration of the presented subjective as well as the published clinical findings (9), TTS and WCS can be particularly recommended for splinting of traumatized teeth; both splints only minimally irritate the soft tissues and are well tolerated by the patients. In addition, the TTS is characterized by shorter application and removal working times, what might be of importance with the younger patients in mind.

References

Fig. 8. Impairment of speech (mean values and standard errors). Significant differences (P < 0.05) are marked.

Fig. 9. Impairment of oral hygiene (mean values and standard errors). Significant differences (P < 0.05) are described in the text.
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