Prognostic Factors for Clinical Outcomes According to Time after Direct Pulp Capping

Sin-Yeon Cho, DDS, Deog-Gyu Seo, DDS, MSD, PhD,† Shin-Jae Lee, DDS, MSD, PhD,‡ Junghyun Lee, DDS, MSD,* Seung-Jong Lee, DDS, MSD, PhD,* and Il-Young Jung, DDS, MSD, PhD**

Abstract

Introduction: Direct pulp capping is a treatment option for teeth with carious-exposed pulp. Because pulp capping studies have exhibited fluctuations in success rates according to different follow-up times, investigating the clinical pulpal survival rate and the potential factors contributing to the survival with respect to time is necessary. **Methods:** A total of 175 patients treated between November 2007 and August 2010 met the inclusion criteria. During the follow-up, we investigated 7 clinical variables with respect to the survival of the pulp capping treatment: sex, age, maxilla versus mandible, tooth position, capping materials, temporary filling materials, and exposure site. Survival analysis was performed using the Kaplan-Meier method and the Cox proportional hazard regression model. **Results:** The Kaplan-Meier survival curves and log-rank tests revealed that only age, exposure site, and capping material had significant effects on the pulpal survival rate ($P < .05$). A Cox regression model showed that mineral trioxide aggregate was the sole factor affecting the survival of the treated pulps ($P < .05$). In the analyses performed separately according to time, there was no conspicuous factor that affected the survival rate before 100 days. However, after 100 days, the type of pulp capping material was the single most important factor influencing the survival rate ($P < .05$). **Conclusions:** The results of this study indicated that careful patient selection and the type of pulp capping material should be taken into consideration when performing a pulp capping treatment. *(J Endod 2013;39:327–331)*

Key Words

Direct pulp capping, mineral trioxide aggregate, survival analysis

Many clinicians are reluctant to choose direct pulp capping as a treatment option for cariously exposed pulps because there are conflicting data regarding the success rates (ie, approximately 37%–100%) (1–4). Additionally, if the capping fails, the tooth can descend into irreversible pulpitis, and the patient may experience severe pain (5). However, compared with pulpectomy or pulpotomy, direct pulp capping is a minimally invasive procedure that saves time, cost, and effort for both clinicians and patients. Therefore, this treatment option is valid from a socioeconomic point of view (6).

To increase the success rate of pulp capping, many authors have tried to identify potential prognostic factors that can influence the outcome, some of which have been claimed to be critically important (1, 4, 7–9). For example, clinical studies have revealed positive results with the use of mineral trioxide aggregate (MTA) (4, 10).

In contrast, some failures, especially those that occur soon after pulp capping, may be caused by the previous impaired condition of the pulp rather than other factors (11). Accordingly, the analysis of all cases, including the early failures, may not precisely indicate the effect of other factors on the outcomes of pulp capping. Therefore, we suggest that the late failures should be analyzed separately to properly evaluate the effect of potential factors.

Recently, some investigators have applied survival analysis to evaluate the outcome of direct pulp capping (8, 9, 12). Previously, other investigators simply reported the success or failure rates of the treatment at specific follow-up times (1, 3, 4, 7, 13, 14). In addition to the advantage of being able to include the cases that dropped out during the study period, the survival statistics enable us to analyze the effects of certain factors on outcome over time (15, 16). This advantage is useful when comparing the causes of early and late failures. The aims of this study, in conjunction with the survival analysis, were to evaluate the treatment outcome of direct pulp capping in permanent teeth with cariously exposed pulps and to investigate the potential factors contributing to the pulpal survival according to time.

Materials and Methods

Subjects

All pulp cappings were performed at the Department of Conservative Dentistry, Yonsei University Dental Hospital, Seoul, Korea. Using an electronic clinical database, we searched for patients with a history of direct pulp capping performed between November 2007 and August 2010. Of the 245 patients searched, 33 cases were

From the *Department of Conservative Dentistry and Oral Science Research Center, College of Dentistry, Yonsei University, Seoul, Korea; and Departments of †Conservative Dentistry and Dental Research Institute and ‡Orthodontics and Dental Research Institute, Seoul National University School of Dentistry, Seoul, Korea.

Sin-Yeon Cho and Deog-Gyu Seo contributed equally to this article.

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Address requests for reprints to Dr Il-Young Jung, Department of Conservative Dentistry, Dental College, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-752, Korea. E-mail address: juen@yuhs.ac

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excluded because no follow-up was conducted after the treatment, and 37 cases were excluded because of recording deficiencies in their charts. The institutional review board for the protection of human subjects reviewed and approved the research protocol.

Treatment Protocol

The general indications for the pulp capping procedures used in our clinic were as follows:

1. Symptomatic teeth without a history of spontaneous pain and sensitive only to provoked stimuli (cold or heat)
2. Teeth with no percussion sensitivity
3. Teeth that could be isolated by a rubber dam
4. Patients in whom there was no difficulty controlling bleeding from the exposure site

Block or infiltration anesthesia was administered, and a rubber dam was placed to isolate the tooth. The caries were removed using mechanical excavation with a low-speed round bur and a spoon excavator. When the pulp was exposed by the caries excavation process, the cavity was disinfected with 2.5% sodium hypochlorite with a syringe and a cotton pellet, which was left at the cavity. If bleeding control was not achieved within 10 minutes, we excluded the case from the indications of pulp capping. After controlling the bleeding, calcium hydroxide cement (Dycal; Dentsply DeTrey, Konstanz, Germany) or white MTA (ProRoot MTA; Dentsply, Tulsa, OK) was used as the capping material. After applying the capping material, the cavity was filled with IRM (IRM Type III; Class I, Dentsply, Milford, MA) or resin-modified glass ionomer (GC Fuji II LC; GC Corp, Tokyo, Japan), which were used as provisional filling materials. Some cavities were restored directly without a provisional filling using either XP Bond (Dentsply DeTrey) or AdheSE (Ivoclar Vivadent, Schaan, Liechtenstein) as bonding agents, a composite resin (Premisa; Kerr Corp, Orange, CA), and/or a flowable resin (Metafil Flo; Sun Medical, Shiga, Japan). In some cases of MTA application, a moistened cotton pellet was placed directly over the MTA followed by the provisional filling material. When the bonded composite resin was used immediately after the application of MTA, the unset MTA was overlaid with a thin protective layer of resin-modified glass ionomer or flowable resin before the bonding procedure. All pulp cappings were performed by the faculty and residents (postgraduate students) at the Department of Conservative Dentistry, Yonsei University Dental Hospital. When the tooth was judged to have a normal pulp at the subsequent visit (usually 2 months after capping), direct filling (using a bonded composite resin), inlay or onlay (using resin or gold), or a full-veneer gold crown was placed over the tooth depending on the shape and size of the cavity. The patients were followed up at 1, 3, and 6 months and every 6 months thereafter. A routine examination was performed on every recall visit, and a periapical radiograph was taken at 3 and 6 months and every 6 months thereafter.

Evaluation Variables

Failure of the pulp capping treatment was recorded as an event. Failure was defined as the following:

1. Root canal treated
2. Pulp necrosis with apical periodontitis
3. Symptomatic pulp that showed spontaneous or lingering pain to thermal stimuli at recall

The teeth were classified as "pulpal survival" when there was a positive response without lingering sensation to the cold test using ice or refrigerant spray, the absence of clinical signs and symptoms, and no apical radiolucency on the periapical radiograph. Subjects without a failure event during the follow-up times were noted as "censored" because the timing of the failure event could not be determined. Seven clinical explanatory variables (ie, sex, age, maxilla vs mandible, tooth position, capping materials, temporary filling materials, and exposure site) were recorded. Removal of the alumina-toughened zirconia abutment because of its fracture was designated as a failure.

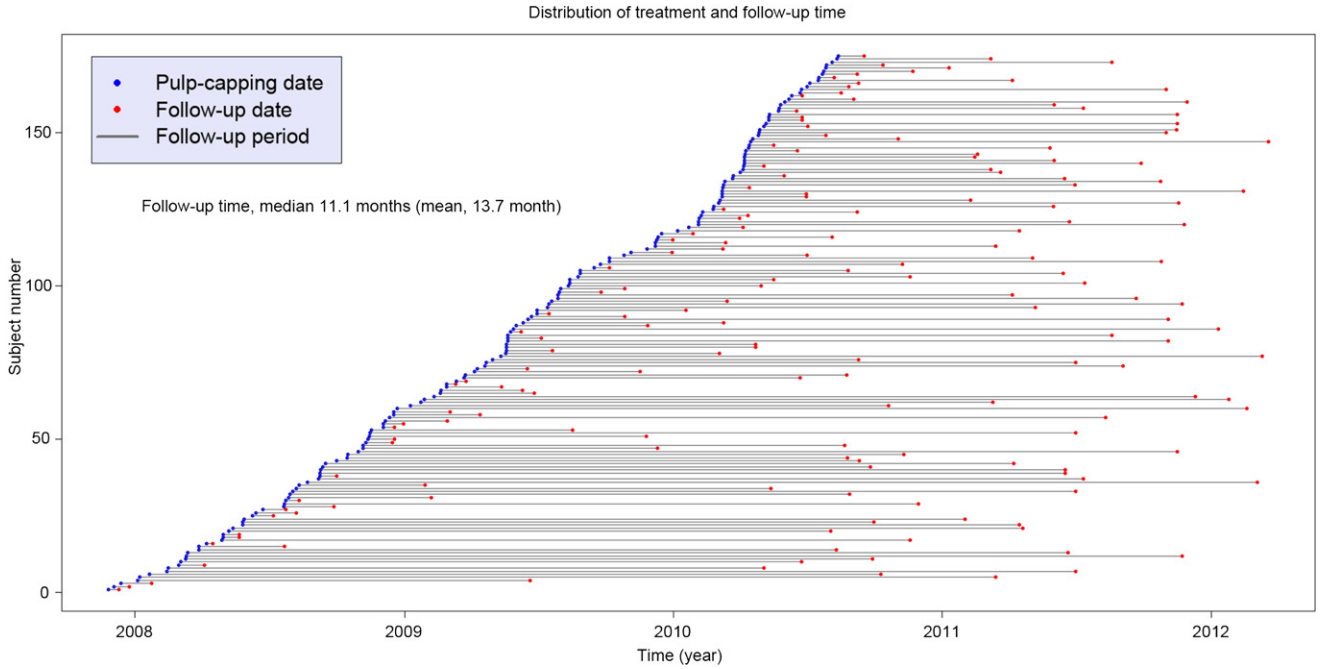

Figure 1. The distribution of the treatment and follow-up times from November 2007 to March 2012. A total of 175 patients are sorted on the y-axis according to the date of the pulp capping treatment on the x-axis.