The Effect of Rubber Dam Usage on the Survival Rate of Teeth Receiving Initial Root Canal Treatment: A Nationwide Population-based Study

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Abstract

Introduction: It is well-known that the usage of rubber dams during root canal treatment (RCT) improves infection control and treatment efficacy and protects patients. However, the effect of rubber dam usage on endodontic outcomes remains uncertain. The aim of the present study was to investigate whether rubber dam usage affects the survival rate of initial RCT using a nationwide population-based database. Methods: A total of 517,234 teeth that received initial RCT between 2005 and 2011 met the inclusion criteria and were followed until the end of 2011. Univariate and multivariate Cox proportional hazards models were used to estimate the effects of rubber dam usage on the risk of tooth extraction after initial RCT. Results: Of the 517,234 teeth, 29,219 were extracted, yielding a survival rate of 94.4%. The survival probability of initial RCT using rubber dams after 3.43 years (the mean observed time) was 90.3%, which was significantly greater than the 88.8% observed without the use of rubber dams ($P < .0001$). After adjusting for age, sex, tooth type, hospital level, tooth scaling frequency per year after RCT, and systemic diseases, including diabetes and hypertension, the tooth extraction hazard ratio for the RCT with rubber dams was significantly lower than that observed for RCT without rubber dams (hazard ratio = 0.81; 95% confidence interval, 0.79-0.84). Conclusions: The use of a rubber dam during RCT could provide a significantly higher survival rate after initial RCT. This result supports that rubber dam usage improves the outcomes of endodontic treatments. (J Endod 2014;40:1733–1737)

Key Words

Initial root canal treatment, rubber dam, survival analysis, survival rate

The aim of root canal treatment (RCT) is to save the patient’s natural tooth from extraction and maintain the tooth’s health and function. To achieve this goal, dentists perform a series of procedures that include eliminating microorganisms from within the root canal system and then sealing the canal space with adequate filling material. During treatment, it is important to isolate the treated tooth from the surrounding oral environment to control the possibility of cross infection and to create an aseptic operating field so that the treatment outcome will be promising. Therefore, the use of a rubber dam during RCT is highly recommended and has been regarded as standard care by professional organizations (1, 2).

The rubber dam was introduced to the dental practice in 1864 (3). Three major advantages of rubber dam usage during root canal treatment include improved infection control, patient protection, and greater treatment efficacy (4). Although the benefits are understandable and pronounced, the prevalence of rubber dam usage in Taiwan is only 16.5% (5). In contrast, the relative effectiveness of rubber dam usage on the endodontic outcomes remains uncertain.

In 1992, Gutmann (6) defined the success or failure of endodontic outcomes using clinical, radiographic, and histologic factors that focused on the periapical status of the treated tooth, such as periapical healing and post-treatment disease, to determine whether the ultimate goal of endodontic treatment had been achieved (1). Additionally, tooth survival rates and tooth retention rates have been suggested as alternative measured for the evaluation of RCT outcomes (7–11). Although the survival rate does not accurately reflect the prognosis of endodontic treatment, it is useful for epidemiological studies to compare the outcomes of various treatment modalities (12). The aim of the present study was to investigate whether rubber dam usage affects the survival rate of initial RCT using a nationwide population-based database.

Materials and Methods

Study Database

The Taiwan National Health Insurance program, which provides health care through compulsory health insurance and covers nearly 99% of the nearly 23.5 million residents of the Taiwanese population, began in 1995. Our study database used the records of the Longitudinal Health Insurance Database 2005, which spans from 2001–2011, and included the registration and medical claims of 1,000,000 randomly sampled patients from the total number of National Health Insurance beneficiaries in 2005. There were no statistically significant differences in age and/or sex between the sampled group and the entire set of enrollees. Many researchers have published
endodontic articles that have used this database to conduct longitudinal and epidemiological studies (9, 10, 13).

**Study Population**

We included all of the teeth that had received initial RCT from 2005–2011 that were in the Longitudinal Health Insurance Database 2005 (90001C for 1-canal system, 90002C for 2-canal system, 90003C for 3-canal system, 90019C for 4-canal system, and 90020C for 5-or-more canal system). The retreatment cases were identified by a specific treatment code (90094C) during RCT, and those cases that were previously treated between 2001 and 2004 were excluded. Each tooth was followed from the completion date of its endodontic procedure until the end of 2011, which produced a maximum follow-up period of 7 years. The teeth that were extracted after RCT during the follow-up period were identified by the specific treatment codes for simple or complicated tooth extraction (92013C, 92014C, 92015C, and 92016C). This study was approved by the Institutional Review Board of Taipei Veterans General Hospital (approved number: 2012-12-009BCY).

Rubber dam usage was identified by a specific treatment code (90012C) during each endodontic session. The claiming of this code requires supporting evidence such as a periapical radiographic film or a clinical photograph. “Good” treatment quality was also identified by specific treatment codes (90095C, 90096C, and 90097C) in the database during the endodontic sessions, and this designation demands both an adequate filling length and dense and complete obturation in the apical third of the root canal (14). The diagnoses of the teeth that received RCT were made according to the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM). Teeth without endodontic diagnoses (ICD-9-CM: 522.0–522.9) were excluded. The urbanization level of the residences and monthly incomes of the patients were also retrieved from the database to determine the socioeconomic status of each patient. The urbanization levels were categorized into 7 clusters based on the Taiwanese census data from 2000 (15).

Additionally, we considered several systemic diseases, including diabetes mellitus (ICD-9-CM: 250, including types I and II), hypertension (ICD-9-CM: 401–405), coronary artery disease (ICD-9-CM: 411–414), and hyperlipidemia (ICD-9-CM: 272), that were associated with tooth extraction in our analytic model (13, 16). To ensure the accuracy of the data accuracy, cases were included only when the patients had been given their diagnoses 3 or more times during outpatient visits or once or more during inpatient services in each year.

**Statistical Analyses**

The demographic and clinical characteristics of the patients whose teeth received RCT were analyzed with Student *t* tests and Mantel-Haenszel chi-square tests for the differences between the teeth that receive initial RCT with a rubber dam and those that received RCT without a rubber dam. Univariate and multivariate Cox proportional hazards models were used to estimate the effect of rubber dam usage on the risk of tooth extraction after RCT during the period from 2005–2011. Potential confounding factors, such as age, sex, tooth type, hospital level, tooth scaling frequency per year after RCT, and systemic diseases, were adjusted in the Cox regression analyses. All statistical tests were performed using SAS 9.2 software (SAS Institute Inc, Cary, NC), and the level of significance was set at *P* < .05 (2-tailed).

**Results**

A total of 517,234 teeth matched the inclusion criteria in the time period of 2005–2011 (mean observed time = 5.43 years); 29,219 of these teeth were extracted, which yielded an overall survival rate of 94.4%. The survival rate of the teeth that received RCT with a rubber dam was 95.15% (73,728/77,489), which was significantly higher than the 94.21% (414,287/439,475) that was observed for the teeth that received RCT with a rubber dam (Table 1, *P* < .0001). Table 1 shows the distributions of the demographic and clinical characteristics for the teeth that received RCT during the period of 2005–2011. The older patients had undergone a greater number of RCTs without the use of rubber dams (*P* < .0001). Molars were more likely to undergo treatments that involved rubber dams compared with anterior teeth and premolars (*P* < .0001). A greater percentage of the RCTs that were performed in hospitals, including medical centers, regional hospitals, and district hospitals, used rubber dams compared with those that were performed in local clinics. The patients who received RCT with rubber dams were more likely to have diabetes, hypertension, coronary artery disease, and hyperlipidemia than were those who received RCT without rubber dams (all *P* < .0001).

Figure 1 shows the cumulative survival probabilities for the teeth that received RCT during 2005–2011 segregated by rubber dam usage. The survival probability of RCT that used rubber dams after 3.43 years (the mean observed time) was 90.3%, which was significantly higher than the 88.8% observed among those that did not use rubber dams (*P* < .0001, log-rank test). Cox proportional hazards regression analysis showed that the crude hazard ratio (HR) for tooth extraction was 0.89 times lower for the teeth that received initial RCT with a rubber dam (95% confidence interval [CI], 0.86–0.92, *P* < .0001) than for the teeth that underwent RCT without a rubber dam. After adjusting for potential confounding factors that included age, sex, tooth type, hospital level, tooth scaling frequency per year after RCT, and systemic diseases, including diabetes and hypertension, the adjusted HR for tooth extraction for the teeth that received RCT with a rubber dam was 0.81 (95% CI, 0.79–0.84), which was significantly better than that for the teeth that received RCT without a rubber dam (*P* < .0001, Table 2). Multivariate Cox proportional hazards regression analyses indicated that the effect of rubber dam usage results in a significantly higher survival rate at 5.43 years after initial RCT.

**Discussion**

The present study explored the effect of rubber dam usage on the survival rate of the teeth that received initial RCT from 2005–2011; 517,234 teeth were analyzed, and the overall survival rate was 94.4%. This rate is similar to those reported in other epidemiologic surveys that have used insurance records. Lazarski et al (7) reported a 94.44% survival rate for nonsurgical RCT teeth that remained functional over an average follow-up time of 3.5 years. Salehrabi and Rotstein (8) reported that 97% of teeth survived for 8 years after primary nonsurgical RCT. Finally, using the same database as ours, Chen et al (9) reported a survival rate of 92.9% at 5 years after nonsurgical RCT. These studies indicate that RCT is a valuable dental procedure because of the high survival rate.

The present study found a relatively low rubber dam usage prevalence (15.0%) in Taiwan. This result is similar to that of the study by Lin et al (5) in 2011 that used data from 2004 that were extracted from Taiwan’s National Health Insurance Research Database (NHIRD). These authors reported a rubber dam usage prevalence of 16.5% (5). Rubber dam usage during RCT provides an aseptic operating field that can prevent contamination from blood and saliva, improve visibility by retracting soft tissues and isolating the tooth, minimize conversation with the patient to improve treatment efficiency, and protect the patient from swallowing or aspirating instruments into their gastrointestinal or respiratory tracts (4). Furthermore, rubber dam usage might be associated...