Table 6. Summaries of Classic Studies Associated with Vital Pulpal Treatments (Pulpotomies, etc)

Cvek, M.	A clinical report on partial pulpomtomy and capping with calcium hydroxide in permanent incisors with complicated crown fracture. *J Endod.* 4:232-237, 1978.	The exposed pulps of 60 permanent incisors with complicated crown fractures were treated with partial pulpotomy and calcium hydroxide dressing. The interval between accident and treatment varied from 1 to 3 months (majority of cases were treated within 2 days of the accident). The size of the pulpal exposure varied from 0.5 to 4.0 mm. Of the teeth, 28 had immature roots, and 32 had mature roots.	The treatment was successful in 58 teeth, or 96%, according to the following criteria: no clinical symptoms, no radiiographically observed intraradicular of periradicular pathologic changes, continued development of an immature root, radiographically observed and clinically verified hard-tissue barrier, and sensitiivity to electrical stimulation. The follow-up examination varied from 14 to 60 months, with an average of 31 months.
Cvek, M. Cleaton-Jones PE, Austin JC, Andreason JO	Pulp reactions to exposure after experimental crown fractures or grinding in adult monkeys. *J Endod.* 1982 Sep;8(9):391-7.	The purpose of this study was to assess the depth of inflammatory reactions in the exposed pulps of crown-fractured and ground teeth. Thirty-six incisors in 11 adult monkeys were used for the experiments. Pulpal reactions were examined after 3, 48, and 168 hours (1 week).	In all 3 groups, on average, the depth of inflammatory changes did not exceed more than 2 mm. Conclusion: In crown-fractured teeth showing vital pulp tissue after an exposure period of 7 days after injury, not more than 2 mm of pulp beneath the exposure needs to be removed for a successful result.
Fuks AB, Bielak S, Chosak A	Clinical and radiographic assessment of direct pulp capping and pulpotomy in young permanent teeth. *Pediatr Dent.* 4:240, 1982.	Seventy-six vital permanent incisors with complicated crown fractures in 72 children were assessed clinically and radiographically for the healing of pulp exposures treated by direct pulp capping or by pulpotomy. Thirty-eight of these teeth had pinpoint exposures and complete roots, and were treated by pulp capping. Pulpotomy was the treatment for the other 38 teeth that had incomplete root development.	Regardless of the size of the exposure, a success rate of 92% was observed in the teeth, which were treated by pulpotomy, and 81.5% was the success rate of teeth treated by direct pulp capping.
Cvek M, Lundberg M	Histological appearance of pulps after exposure by a crown fracture, partial pulpotomy, and clinical diagnosis of healing. *J Endod.* 1983;9:8–11.	The purpose of this study was to assess healing in the pulps of teeth treated with partial pulpotomies. All teeth had large fractures that would eventually need full pulpectomy (post, core, and crown), allowing for histological examinations anywhere from 2 to 8 years later. Pulps removed from a series of 21 crown-fractured incisors, which had been treated by partial pulpotomies and clinically judged as healed 12 to 95 months (8 years) after treatment, were examined histologically. Success was judged by lack of symptoms, continued vitality, and dentin bridge formation.	Histological examination of tissue after partial pulpotomy revealed some calcification and minimal inflammation. Histological observations confirmed the clinical diagnosis of healing, and it was, therefore, concluded that pulpotomy can be used as a definitive treatment, and the routine use of pulpectomy after partial pulpotomy treatment of exposed vital pulps in crown-fractured teeth does not appear justified.
Fuks AB, Cosack A, Klein H, Eidelman E	Partial pulpotomy as a treatment alternative for exposed pulps in crown fractured permanent incisors. *Endod Dent Traumatol.* 1987, June;3:1002.	Sixty-three vital permanent incisors with complicated crown fractures were treated by partial pulpotomies and assessed clinically and radiographically for healing. Healing of the pulp was considered to have taken place when the following criteria were fulfilled: absence of clinical symptoms, radiographic evidence of dentin bridge formation, no intrapulpal or periapical pathosis, continued root development in immature teeth, and a positive response to electrical pulp testing. Follow-up time ranged from 6 months to 4 years. The time elapsed from the injury until the emergency treatment varied from 2 hours to 3 weeks.	The treatment was successful in 59 teeth (94%).
Fuks A, Gavra S, Chosak A	Long-term follow-up of traumatized incisors treated by partial pulpotomy. *Pediatric Dentistry*. 1993;15:334.	The purpose of this study was to assess the long-term success of partial pulpotomies in incisors. This was a follow-up study to Fuks et al (1987).	Out of the 59 teeth that were a success, 40 were recalled 7.5 to 11 years later. Out of the 40 teeth examined at the second recall, 35 were successful (87.5%). Success was previously defined during part 1 of this study.
Cvek M	Partial pulpotomy in crown fractured incisors: results 3 to 15 years after treatment. *Acta Stomatol Croat.* 1993;27:167–73.	The pulp exposed by a crown fracture in 178 incisors in patients aged between 6 to 17 years old was treated with partial pulpotomy ("Cvek") and dressing with calcium hydroxide. A majority of the teeth were treated within 24 hours of the traumatic exposure. There were many teeth (n=72) that were sensitive to percussion at the time of treatment. There was an almost-equal distribution of roots that were considered mature and developed vs those which were immature and "open."	On follow up, a hard-tissue barrier below the calcium hydroxide was found in the majority of teeth. Healing had occurred in 169 out of 178 teeth, or in 95%. The followup ranged from 3 to 15 years after treatment. Success was judged by continued vitality, lack of symptoms, and dentin bridge formation.
Mejare I, Cvek M	Partial pulpotomy in young permanent teeth with deep carious lesions. *Endod Dent Traumato*l. 9:238, 1993.	Thirty-seven young posterior teeth (mostly molars) with deep carious lesions and exposed pulps were treated with partial pulpotomies and dressed with calcium hydroxide under rubber dam isolation. Success was judged by lack of symptoms, continued root growth, and vital pulp.	A 93.5% success rate was observed over an average observation of 2 to 11 years. The results of this study indicate a high frequency of pulpal healing in young posterior teeth when superficial layers of the pulp beneath a carious exposure were removed, provided that all surrounding carious dentin was removed, the pulp wound was dressed with calcium hydroxide, and the coronal cavity was sealed.
Barthel CR, Rosenkranz B, Leuenberg A, Roulet JF	Pulp capping of carious exposures: treatment outcome after 5 and 10 years: a retrospective study. *J Endod.* 2000 Sep;26(9):525-8.	One-hundred twenty-three pulp-capped teeth were followed for 10 years. All pulps were exposed during caries excavation. The cavities were carefully cleansed with 3% H_2O_2, and a setting $Ca(OH)_2$ was placed on the wounds. The pulp capping was considered "successful" when the tooth responded clearly to sensitivity testing. There had to be no clinical symptoms or radiographic pathology. The pulp capping was rated as a "failure" if the tooth was extracted or root-canal-treated (surgically or nonsurgically) or if apical rarefaction was detected radiologically.	Five-year success: 37%. Five-year failure: 44.5%. Five-year questionable: 18.5%. Ten-year success: 13%. Ten-year failure: 79.7%. Ten-year questionable: 7.3%. The placement of a definitive restoration within the first 2 days after pulp exposure was found to contribute significantly to the survival rate of these teeth. There should be reconsideration of whether direct pulp capping should be the treatment of choice in cases of carious pulpal exposures.
Mente J, Geletneky B, Ohle M, Koch MJ, Friedrich Ding PG, Wolff D, Dreyhaupt J, Martin N, Staehle HJ, Pfefferle T	Mineral trioxide aggregate or calcium hydroxide direct pulp capping: an analysis of the clinical treatment outcome. *J Endod.* 2010 May;36(5):806-13.	One-hundred twenty-two treated teeth were available for followup after pulp capping with either calcium hydroxide or MTA. The followup was, on average, between 1 to 7 years after treatment.	A successful outcome was recorded for 78% of teeth (54 of 69) in the MTA group and for 60% of teeth (32 of 53) in the calcium hydroxide group. MTA appears to have a higher success rate. The average success rate for both was 69%. The tendency for the success rate in the teeth capped with $Ca(OH)_2$ to drop after a follow-up period of 2 to 3 years and more than 3 years is striking; in the MTA group, the success rate is relatively constant over time.
Mente J, Hufnagel S, Leo M, Michel A, Gehrig H, Panagidis D, Saure D, Pfefferle T	Treatment outcome of mineral trioxide aggregate or calcium hydroxide direct pulp capping: long-term results. *J Endod.* 2014 Nov;40(11):1746-51.	This controlled, historic cohort study project continued a previously reported trial aiming to assess treatment outcomes of direct pulp capping with mineral trioxide aggregate (MTA) vs calcium hydroxide (CH). Clinical and radiographic outcomes of 229 teeth treated with direct pulp capping between 2001 and 2011 were investigated up to 10 years post-treatment. (Exposed pulps were treated with cotton soaked with chlorhexidine to achieve hemostasis. If bleeding wasn't controlled within 5 minutes, this was an indication of irreversible pulpitis, and pulp capping was not done.)	The overall success rates were 80.5% of teeth in the MTA group and 59% of teeth in the CH group. Teeth that were permanently restored 2 or more days after direct pulp capping had a significantly worse prognosis irrespective of the pulp capping material chosen. The results of this study indicate that MTA provides better long-term results after direct pulp capping compared with CH. Placing a permanent restoration immediately after direct pulp capping is recommended.
Elmsmari F, Ruiz XF, Mir Q, Feijoo-Pato N, Dur n-Sindreu F, Olivieri JG	Outcome of Partial Pulpotomy in Cariously Exposed Posterior Permanent Teeth: A Systematic Review and Meta-analysis. *J Endod.* 2019 Nov;45(11):1296-1306.	This systematic review and meta-analysis aimed to evaluate the success rate of partial pulpotomies in treating permanent posterior teeth with carious vital pulp exposures. Only randomized clinical trials and prospective clinical studies were included for evaluation. Eleven studies qualified for the final analysis.	Success at 6 months: 98%. Success at 1 year: 96%. Success at 2 years: 92%. The most important factor in terms of predicting success was preoperative diagnosis. If the pulp was diagnosed with irreversible pulpitis, the success for partial pulpotomy was significantly lower (75%). According to the results of the present systematic review and meta-analysis, a partial pulpotomy is considered a reliable treatment option for the treatment of cariously exposed permanent posterior teeth. It presents a high success rate of 92% after 2 years. There is no significant difference between MTA-like materials and CH as a pulp capping agent.
Sabeti M, Huang Y, Chung YJ, Azarpazhooh A	Prognosis of Vital Pulp Therapy on Permanent Dentition: A Systematic Review and Meta-analysis of Randomized Controlled Trials. *J Endod.* 2021 Sep 1:S0099-2399(21)00602-6	The aim of this systematic review was to evaluate the existing randomized controlled trials (RCTs) on the safety and efficacy of vital pulp therapy (VPT) and to analyze the outcomes of VPT performed with a variety of pulp-capping materials and techniques. VPT encompasses pulp capping, partial pulpotomy (PP), and full pulpotomy (FP). It has been indicated for reversible pulpitis in the absence of periapical pathologies, noncarious pulpal exposure, and immature teeth to allow the continuation of root development.	Fourteen studies were included. The pooled success rate of VPT using contemporary capping materials such as mineral trioxide aggregate (MTA) or calcium silicate–based materials (CSMs) was 93.2%.