Cost-effectiveness of Different Post-retained Restorations

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Abstract

Objectives: Dentists can choose between metal and fiber post systems to provide post-retained restorations. The risk of tooth loss and other complications differs between different post systems, as do the initial treatment costs. We aimed to assess the cost-effectiveness of (1) cast metal (MC), (2) preformed metal (MP), (3) glass fiber (GF), and (4) carbon fiber (CF) post-retained restorations. **Methods:** A mixed public-private payer's perspective within German healthcare was taken. Risks of complications were extracted from systematic reviews. Costs were estimated by using fee items and 2016 material costs. A Markov model was constructed to follow up an endodontically treated molar receiving a post-retained crown in an initially 50-year-old patient during his lifetime. Monte Carlo microsimulations were performed to assess lifetime costs and tooth retention time. **Results:** MPs were least costly (692€), retaining teeth for 26.7 years. GFs were more costly (745€), retaining teeth for 27.6 years. MCs were minimally more effective but also more costly than GFs (774€). CFs were less effective and most expensive (825€, 26.7 years). For payers willing to invest more than 60€ per tooth retention year, GF was cost-effective. Payers willing to invest an additional 670€ found MC to be cost-effective. These findings were found robust in sensitivity analyses. **Conclusions:** For payers not willing to invest additional money for longer tooth retention, MP seemed most suitable to retain restorations. For payers with additional willingness to pay, GF seemed suitable, retaining teeth for longer. MC was only cost-effective under very high willingness to pay. CF is not recommendable on the basis of their cost-effectiveness. *(J Endod 2017;43:709–714)*

Key Words

Computer modelling, dental care, fiber posts, health economics, Markov model, prosthetics

Significance

We found preformed metal post-retained restorations to be least costly, whereas glass fiber post-retained restorations were moderately more expensive but also more effective. Clinical decision-making should consider both the initial treatment costs and also costs associated with possible long-term complications.

To restore endodontically treated teeth with limited coronal tooth hard tissue, post-retained restorations (crowns) are often required. For such post-retained restorations, clinicians can use metal posts or non-metal fiber posts. Metal posts can either be cast, often as post-core casts, or preformed, with the core being directly placed after cementation of the post. Fiber posts are usually preformed and contain carbon, quartz, or glass fibers, which are embedded in an epoxy or methacrylate matrix. These are usually adhesively luted, with the core being directly placed. In contrast to metal posts, the elastic modulus of fiber posts is similar to dentin (1, 2), which should assist to distribute the stress under load, reducing the risk for vertical root fracture (3–6).

In contrast to the results from *in vitro* studies, clinical studies found the risk of such fatal complications to be similar in teeth with metal versus fiber post-retained restorations; however, risks seem to differ in different types of metal and fiber posts (7). Moreover, the risk of non-fatal complications might be different between different post types too (7). At present, there is ambiguity with regard to the suitability of different post systems, with no clear guidance being available for clinicians as to which system is most appropriate (8).

One aspect that has so far not been assessed when comparing different post-retained restorations is cost-effectiveness: The placement of different posts involves different efforts; for laboratorial manufacturing or adhesive luting, these differences will lead to different initial treatment costs. Moreover, different risks will generate different long-term costs for mending complications such as recementation, re-restoration, or replacement. Assessing such long-term consequences of treatments and retreatments is complex.

The present study aimed to assess the cost-effectiveness of different post-retained crowns. To reflect the discussed long-term aspects, a model-based approach was chosen. The findings of this study are relevant for payers, clinicians, patients, and healthcare researchers alike because they might assist to guide clinical and non-clinical (health services) decision-making as well as the conduct of future studies.

Methods

Setting, Perspective, Population, Horizon

This study adopted a mixed public-private payer perspective in the context of German healthcare. We modeled a population of initially 50-year-old men with a molar tooth that had completed endodontic treatment of a vital, painless pulp with 3 root canals. Molars were assumed to require a post-retained crown and were followed

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during the patient's lifetime (TreeAge Pro 2013; TreeAge Software, Williamstown, MA), which was determined by age and gender.

All cost-effectiveness evaluations were performed per 1 molar to avoid clustering and the associated issues of correlation and to increase the ease of interpretation of our findings. Note that for this study, we did not specify any further factors that influence the survival of post-retained teeth such as root canal and post shape, post preparation type, or specific cementation or adhesive luting materials, etc.

Comparators

We compared 4 strategies:

1. A cast metal post-retained crown (MC)
2. A preformed (passive) metal post-retained crown (MP)
3. A glass fiber post-retained crown (GF)
4. A carbon fiber post-retained crown (CF)

Metal posts were assumed to be cemented conventionally, whereas fiber posts were assumed to be luted adhesively. The placed crown was assumed to be a full non-precious metal crown, as is standard under the assumptions of the statutory insurance in Germany for molars.

Model and Assumptions

Molars were assumed to experience fatal and non-fatal complications, the risks of which were extracted from a recent systematic review for the different comparators (7). Fatal complications were those leading to the tooth being extracted (mainly root fractures). Non-fatal complications were those needing retreatments, including endodontic complications, decementation or crown dislodgments, fractures, secondary caries, etc. The risk of complications and the probabilities of allocation to different treatments mending these complications are given in Table 1.

Endodontic complications were assumed to be mended by nonsurgical (orthograde) or surgical retreatment (apisectomy). The risks of endodontic complications were derived from existing studies in the field and systematic reviews (Table 1). Teeth that had experienced orthograde retreatment were treated surgically in case of further endodontic complications; those that had received surgical retreatment were extracted in case of further endodontic complications. We varied the proportion of endodontic complications being mended surgically or non-surgically between 0% and 100%. In an additional analysis, we assumed teeth with adhesively placed posts to not receive orthograde but only surgical retreatment, whereas those with metal posts were all first non-surgically retreated in case of complications.

Restorative complications (Table 1) were mended by recementation of the crown or renewal of the crown (involving the renewal of the post and core too). We assumed 60% of such complications to be decementations, ie, requiring recementation, and 40% to require renewal of the crown.

In case of teeth that needed removal, their replacement by using implant-supported single crowns was modeled. We assumed 50% of teeth to be replaced in the base-case scenario; this was varied to account for heterogeneity (of patients, etc.). Implant-supported crowns were assumed to be prone for complications from the implant (peri-implantitis, implant fracture), which we assumed to lead to implant removal and in 50% of the cases renewal of the implant, and complications of the crown (decementation, fracture, etc), which we assumed to lead to crown replacement or recementation. Risks of complications of implant-supported crowns were derived from a systematic review (13).

The constructed model is shown in Figure 1. Model validation was performed internally by varying key parameters to check their impact on the results, by evaluating different model structures, and by performing sensitivity analyses.

Health Outcomes and Measurement of Effectiveness

The health outcome was tooth retention years, ie, the mean time a tooth was retained in a patient's mouth. Transition probabilities to allow

TABLE 1. Parameters Used for Effectiveness Estimation

Health state	Reference	Transition probability per year	Triangular distribution*	Allocation to	Allocation probability
Fatal failures					
MC	Figueiredo et al, 2015 (7)	0.0034	0.1, 1.0, 2.2	Removal	0.50
MP		0.0055	0.8, 1.0, 1.2	Removal and replacement	0.50†
GF		0.0036	0.2, 1.0, 1.8		
CF		0.0057	0.6, 1.0, 1.4		
Non-fatal restorative failures‡					
MC	Figueiredo et al, 2015 (7)	0.022	0.3, 1.0, 1.7	Renewal post-crown	0.40
MP		0.013	0.7, 1.0, 1.3	Recementation post-crown	0.60
GF		0.014	0.1, 1.0, 2.3		
CF		0.023	0.7, 1.0, 1.3		
Non-fatal endodontic complications					
RCT	Ricucci et al, 2011 (9); Schwendicke et al, 2014 (10)	$0.0232a^{-0.823}$	—	Non-surgical re-RCT Surgical re-RCT	0.50 0.50†
Non-surgical re-RCT	Ng et al, 2008 (11)	0.059	0.3, 1.0, 2.0	Surgical re-RCT Extraction	0.80† 0.20
Surgical re-RCT	Torabinejad et al, 2009 (12)	0.080	0.5, 1.0, 2.0	Extraction	1.00
Implant complications	Jung et al, 2012 (13)	0.032	0.5, 1.0, 1.7	Renew Remove	0.5 0.5
Implant crown complications	Jung et al, 2012 (13)	0.047	0.6, 1.0, 1.8	Renewal Recementation	0.4 0.6

RCT, root canal therapy.

*Distributions were used to express uncertainty, with triangular distributions being used for random sampling during probabilistic sensitivity analyses.

†Were varied in sensitivity analyses.

‡Note that we modeled endodontic complications separately from the remaining complications outlined as "non-fatal" in the systematic review informing this study (7) to allow modeling of follow-up endodontic complications. Note that this will have increased the overall risk of non-fatal complications, without any difference between groups.