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Comparison of Dental Restoration for Experimentally Induced Cavity with Amalgam, Resin Composite or Glass Ionomer Cement in Dogs

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Abstract: The aim of the study was to compare the clinical usage of filling materials such as amalgam, glass ionomer cement and resin composite. A 2 years old male and weighing 16 kg stray dog, was used. Cavities were made in a routine manner by a frez. Cavities of the buccal surfaces of the left maxillar molar, premolar, canine and incisive teeth were filled with amalgam, cavities of the buccal surfaces of the left mandibular molar, premolar, canine and incisive teeth were filled with glass ionomer cement and cavities of the buccal surfaces of the right mandibular molar, premolar, canine and incisive teeth were loaded with resin composite. The dog was monitored for a period of 6 months for the applicability of dental restorative materials. It was concluded that amalgam and resin composite were more usable than glass ionomer cement in teeth, which were exposed to stress however, resin composite as a restorative material is more demandable if esthetical reason is preferred in veterinary dentistry.

Key words: Amalgam, resin composite, glass ionomer, dog, tooth, Turkey

INTRODUCTION

Major objective of the restorative dentistry is to accomplish or imitate the original biomechanics of the tooth by restoration (Magne *et al*., 1999; Magne and Douglas, 1999). A natural tooth, thanks to its structural and physical relation between the mina (a very solid tissue) and the dentine (softer and more flexible tissue), resists to thermal and masticator outer influences. Understanding of this interaction paved the way to evaluate biomechanical responses a result of restorative procedure of intact solid tissues (Macpherson and Smith, 1995; Dogan *et al*., 2006).

Every loss in teeth structure because of endondontic treatment and cavities causes considerable increase in crown flexibility.

Teeth that endodontically treated are brittle and under high risk of fracture in consequence of moisture lost (Sedgley and Messer, 1992). Selection of adequate restoration procedure for the endodontically treated teeth is important in terms of durability and esthetics (Dogan *et al*., 2006).

An ideal material used for restoration should be adhesive, tooth-coloured, resistant to wear (Matis *et al*., 2004), non-toxic, non-disengagable, biocompatible to the tissue (Bernabe *et al*., 2005), easy to apply and emplace (Tanomaru-Filho *et al*., 2006). Moreover, good adaptation to cavity walls, poor heat conduction, reduced porosity, esthetically congruent particularly in the group of the front teeth, bears radio-opaque fillings, no volume and contour changes, cheap and long shelf-life, compatible with mina-dentin bonding agents, good and permanent at polishing and finishing procedure are all wanted properties (Altun, 2005).

The most commonly used restorative material for posterior teeth is dental amalgam. Notwithstanding the increased demand for the restoration regarding tooth colour, safety and profits are still debatable. Dental amalgam has a number of advantages such as cheap to afford, high level of resistance to wearing, easy to manipulate and apply, no requirements for technical precision, long survival rate and sealing ability to edges in course of time (AL-Jazairy and Nlouka, 1999; Helvatjoglou-Antoniades *et al*., 2000; Hurmuzlu *et al*., 2004; Dupont, 2000), but it has disadvantages such as tooth and colour maladjustment, poor adaptation and insufficient bonding to dental architecture (Dupont, 2000).

Composite filling materials used in the restorative dentistry is the choice for patients and surgeons owing to

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ability of the biocompatibility, no mercury content and its dental colour aspects (Manhart *et al*., 2001). However, such as staining and attenuation of filling resistance as a result of inadequate polymerization in polymerasible composites by the light (Schulze *et al*., 2003), lack of contact marginal adaptation with neighbor teeth and adherence nature to manuel devices during cavity filling are the disadvantages (Cobb *et al*., 2000).

Glass ionomer cements have properties of the adherent ability to mina and dentine and fluorine oscillation and caries protection. High level of wearing rate and weakness against pressures cause the loss of anatomic unity in a short span of time therefore this limits the success rate of its use in the back row of the teeth in clinical fields (McLean, 1992; Mount, 1995).

Thus, this study aimed at comparing the applicability of amalgam, glass ionomer cement and resin composite filling materials in a dog.

MATERIALS AND METHODS

A 2 years old male and weighed 16 kg stray dog obtained from a dog shelter of Afyonkarahisar municipality Turkey was used in the study after the approval of the local ethical board. General health status of the dog was good and has a full vaccination programme.

Dog was fasted for 12 h prior to anaesthesia. Following subcutan administration of 0.045 mg kg^{-1} atropine (Atropin 0.2%, Vetas, Turkey) the dog was premedicated with 2 mg kg^{-1} xylazine HCl (Alfazyne 20 mg kg^{-1}, Alfasan, Turkey) intramuscularly. Induction and mainteinance was achieved by ketamine HCl (Alfamine 100 mg kg^{-1}, Alfasan, Turkey) at a dose of 20 mg kg^{-1} intramuscularly.

Under the anaesthesia the region was surrounded by cotton rolls and salivary absorbent packings. Cavities approximately, 2 mm in diameter by a frez in buccal surfaces of the left maxillar molar, premolar, canine and incisive, left mandibular molar, premolar, canine and incisive, right maxillar molar, premolar, canine and incisive and right maxillar molar, premolar, canine and incisive teeth were prepared.

Restoration procedure

Amalgam restoration: Before the restoration, cavities in the left maxillar molar, premolar, canine and incisive teeth were washed with water and dried. Then, amalgam (Proalloy-70, DMP. Ltd.) was loaded to the cavity by means of a dental filler applicator. Superfluous amalgam was removed and its surface was smoothed.

Glass ionomer cement restoration: Teeth cavities in the right mandibular molar, premolar, canine and incisive teeth were washed with water and dried. Then, glass ionomer cement (Argion Molar AC, VOCO, Germany) was loaded to the cavity prepared using the tooth filler tool. Finally, equality between tooth level and surface of the filling material was achieved.

Resin composite restoration: Teeth cavities in the left mandibular molar, premolar, canine and incisive teeth were washed with phosphoric acid for 120 sec and dried for 15 sec. Into the acidified cavity resin composite (Sistema restarurador, Madespa S.A., Spain) was loaded and hardened by a visible light for 20 sec. Finally, surface of the filling material was smoothed and polished.

Assessment of the restoration: Restoration status was observed at the 1st, 2nd and 3rd months of the study. For the evaluation modified Ryge criteria (USPHS criteria) were considered (Table 1). The critaria for the assessment included colour match, marginal adaptation, marginal staining, presence of the secondary caries and anatomic form were assessed.

Table 1: The criteria for restoration assessment (USPHS criteria)

Criteria	Application type	Assessment criteria
Colour match	With eye and mirror	A: The restoration matches in colour and translucency to the adjacent tooth structure
		B: The mismatch in colour and translucency is within the acceptable range of colour and translucency
		C: The mismatch is outside the acceptable range of colour and translucency
Marginal staining	With eye and mirror	A: There is no discoloration between the restoration and tooth
		B: There is discoloration on less than half of the circumferential margin
		C: There is discoloration on more than half of the circumferential margin
Marginal adaptation	With eye, mirror and probe as required	A: Explorer does not catch or has one-way catch when drawn across the restoration-tooth interface
		B: Explorer falls into crevice when drawn across the restoration-tooth interface
		C: Dentin or base is exposed along the margin
Secondary caries	With eye, mirror, probe and radiography as required	A: There is no clinical diagnosis caries
		B: There is clinical diagnosis caries
Anatomic form	With eye, mirror and probe as required	A: The general contour of the restoration follows the contour of the tooth
		B: The general contour of the restoration dose not follows the contour of the tooth
		C: The restoration has overhang

RESULTS

Amalgam restoration findings: When, amalgam restoration was evaluated with regard to colour match at the 1st, 2nd and 3rd months, it was observed that the consistency and translucency between tooth tissue and restoration was unacceptable in all teeth studied. At the 1st month no colouring was noted between restoration region and neighboring tooth tissue however, slight colouring in all teeth occurred during the 3rd and 6th months.

Indentation between restoration and tooth tissues (in all teeth) was not seen at the 1st month whereas, at the 4th premolar tooth an indentation probed by cannula was visible at the 3rd and 6th months. In all teeth at the end of the 6th month neither the presence of the secodary caries nor the decay of restoration contour was observed in amalgam restorations (Table 2).

Resin composite restoration findings: The evaluation of colour match showed that there was consistency and transluceny between restoration and tooth tissue in all teeth during the 1st and 3rd months. However, at the 6th month translucency was deteriorated. As far as edge colouring concerned no colouring between restoration and tooth tissue was observed at the 1st month, whereas at the 3rd month slight colouring, at the 1st and 3rd premolar teeth was visible and similar findings continued through the 6th month.

At the control, no surface roughness was seen in all teeth. At the end of the 6th month, neither the presence of the secondary caries nor the decay of restoration contour was observed in amalgam restorations (Table 3).

Glass ionomer restoration findings: In all teeth restored by glass ionomer cement it was seen that colour match

Table 2: USPHS scores obtained during periodic control at the 1 st, 3rd and 6th months for amalgam restorations

		Amalgam restorations																					
		1st month							3rd month							6th month						
Criteria		101	102	103	104	105	106	107	101	102	103	104	105	106	107	101	102	103	104	105	106	107
Colour match	A																					
	B	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	C																					
Marginal staining	A																					
	B	A	A	A	A	A	A	A	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	C																					
Marginal adaptation	A																					
	B	A	A	A	A	A	A	A	A	A	A	A	A	B	A	A	A	A	A	A	B	A
	C																					
	D																					
Secondary caries	A																					
	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	C																					
Anatomic form	A																					
(Occlusal-Proximal)	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	C																					

Table 3: USPHS scores obtained during periodic control at the 1st, 3rd and 6th months for composite resin restorations

		Composite resin restorations																					
		1st month							3rd month							6th month						
Criteria		101	102	103	104	105	106	107	101	102	103	104	105	106	107	101	102	103	104	105	106	107
Colour match	A																					
	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	B	B	B	B	B	B
	C																					
Marginal staining	A																					
	B	A	A	A	A	A	A	A	A	A	B	B	A	A	A	A	A	B	B	A	A	A
	C																					
Marginal adaptation	A																					
	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	C																					
	D																					
Secondary caries	A																					
	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	C																					
Anatomic form	A																					
(Occlusal-Proximal)	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	C																					

101: Incisive, 102: Canine, 103: 1. Premolar, 104: 2. Premolar, 105: 3. Premolar, 106: 4. Premolar, 107: Molar, A: Perfect situation, B: Clinically acceptable changes and C: Unacceptable restoration

Table 4: USPHS scores obtained during periodic control at the 1st, 3rd and 6th months for glass ionomer semen restorations

		Glass ionomer semen restorations																				
		1st month							3rd month							6th month						
Criteria		101	102	103	104	105	106	107	101	102	103	104	105	106	107	101	102	103	104	105	106	107
Colour match	A																					
	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	C																					
Marginal staining	A																					
	B	A	A	A	A	A	A	A	A	B	A	A	B	B	B	A	B	A	A	B	B	B
	C																					
Marginal adaptation	A																					
	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	A	A	B	B	B
	C																					
	D																					
Secondary caries	A																					
	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	C																					
Anatomic form	A																					
(Occlusal-Proximal)	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	C																					

101: Incisive, 102: Canine, 103: 1. Premolar, 104: 2. Premolar, 105: 3. Premolar, 106: 4. Premolar, 107: Molar, A: Perfect situation, B: Clinically acceptable changes and C: Unacceptable restoration

and trasluceny between restoration and tooth tissue were not consistent throughout the study. Regarding the marginal staining in all teeth, no colouring between the restoration and along the neighboring tooth edge at the 1st month and slight colourings in canine, 3rd and 4th premolar and molar teeth at the 3rd month were observed and this trend continued at 6th month. No surface roughness was seen between restoration and tooth tissue at the 1st and 3rd months and also, no caries was noted. Slight roughness determined by a probe were encountered in canine, 3rd and 4th premolar and molar teeth. In all teeth at the end of the 6th month, anatomic disorders were not noted after the restoration (Table 4).

DISCUSSION

Restorative dentistry deals with long term preservation of the integrity of the teeth in terms of function and esthetics by natural and anatomical approaches (Magne *et al*., 1999; Magne and Douglas, 1999). However, in veterinary dentistry structural integrity is more demandable than esthetics appearance.

Wet-bonding concept was coined by Kanca (1992) to solve the problems that might occur after excessive drying. According to this notion the dentin is roughened then washed.

Superfluous moisture in the surface is removed by a light air wave or by a piece of dry cotton ball leaving dentin with no humidity (Kanca, 1992). Acetone and particularly ethanal essence primers in adhesive systems may tolerate the excessive humidity without causing any hazards on adhesives (Haller, 2000). In present study, all cavities were dried by application of a slight air wave to prevent excessive wetness of dentine then filling was achieved by loading of amalgam or glass ionomer.

Although, amalgam is a good restorative material in human dentistry, it has no esthetic appearance and contains mercury, which is a toxic substance to human. This caused the need for new filling materials to be developed (Gundogdu and Kirzioglu, 1998; Swift *et al*., 2001a, b). Resin composite is highly demanded by dentists due to its biocompatibility, tooth-colour matching and no mecury content (Manhart *et al*., 2001; Nalcaci and Ulusoy, 2005). Glass ionomer cement adheres directly to enamel and dentine shaping an esthetic and strong filling capacity (Samsar and Akin, 2000).

Recently, owners are willing to pay more for their pets to have better teeth because of esthetical apprehension. Therefore, we believe that the resin composite may be superior to other filling materials.

It was reported that edge colouring after amalgam restoration could be result of amalgam itself, corrosion products or secondary caries (Foster, 1994; Kidd, 1989; Mjor *et al*., 2002; Al Negrish, 2001). Clinical findings such as fractures and grayish colour alterations at the edge of amalgam restoration are very important principal criteria for the renewal of restoration (Foster, 1994; Rudolphy *et al*., 1997).

The one of the most significant reason for the need for the replacement is secondary caries in amalgam restorations (Toraman *et al*., 2004). According to the study on composite restoration by Turkun (2002) slight colour changes in filling interface in 5.2% of cases and after 6 years the probe was slightly tackled in grooves

at the marginal edges in 7.8% cases were observed. Resin composite materials are normally polymerazed by the light. Where, inefficiently polymerised it may cause colouring and decrease in filling power (Manhart *et al*., 2001).

In present study, from the end of 1 month to the end of 6 month the reason for no edge colouring could be due to the colour of amalgam or corrosion products rather than secondary caries. In the resin composite filled teeth slight colouration in the 1st and 3rd premolar teeth at the 3rd and 6th months could be associated with insufficient polymerization by the light.

The amalgam restoration for milk teeth was superior to glass ionomer cement restoration in terms of the anatomical edge continuity.

Metal-added glass ionomer cement may be an alternative option to amalgam and resin composite for short term restoration especially, where there is no direct pressure and cavities are small (Forsten and Karjalainen, 1990).

Moreover, metal-added glass ionomer cement is not rewarding to use in occlusal surfaces of the teeth because of material loss, holes in surface and fissure formations (Wilkie *et al*., 1996). In early stage of filling glass ionomer cement may melt inasmuch as its sensitivity to humidity. The chief problems related to composite resins are secondary caries and erosion (Gundogdu and Kirzioglu, 1998).

Glass ionomer cement has the properties of mina and dentin adhesive, flour oscillation and caries preventive (McLean, 1992; Mount, 1995). Gorgul *et al*. (2001) reported no secondary caries in amalgam and composite resin restoration were observed (Gorgul *et al*., 2001).

In present study, after the 3rd month, a groove the probe easily entered was seen in the 4th premolar. This groove might occur by inadequate smoothing or polishing during the procedure. However, no groove formation was observed in composite resin filled teeth throughout the study.

We believe that because of suitability of higher filling capacity and use in regions where, the stress is significant, the indentations may not occur when, condensable resin composite is used.

The resistance of glass ionomer cement against pressures especially in teeth where, pressure is high is low due to its structural properties (Fuks *et al*., 1984). This may further cause the formation of this clinical appearance. This may explain why surface roughness in canine, the 3rd and 4th premolar and molar teeth were seen in present study.

The secondary caries and anatomical discrepancy were not the case in the current study. This may be associated with the short duration of the study lasted for 6 month. The reason for such a short span of the study is due to monitor the veterinary patients for long term effects of the restoration despite its counterparts in human patients.

CONCLUSION

In veterinary dentistry the availability of restoration materials such as amalgam and composite resin are more demandable in teeth that are exposed to stress in comparison to glass ionomer cement, however, if there is esthetical reason for some teeth the resin composite may be the choice.

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