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## Histological Investigation Of Gingival Reaction To Direct Polymethyl Methacrylate Provisional Restorations

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### ABSTRACT

**Purpose:** This investigation evaluated the possible histological reactions to chairside fabricated methyl methacrylate provisional restorations depending on the time span.

**Materials and methods:** Participants included 30 patients recruited for fixed restorations, where gingival recontouring was indicated to improve esthetics or retention. The teeth were prepared, and provisional restorations were performed by the direct technique to protect the residual tissue, and to be used as index for gingivectomy to harmonize the margins. The cut gingival band was utilized for histological assessment. Patients, who irregularly returned for surgical appointment, took longer periods with provisional restorations in the oral cavity, renewed an appointment for surgery and participated in the study too. The periods were marked and correlated with histological findings.

**Results:** Histological findings recorded a high rate of acute inflammation for gingiva surrounding provisional restorations of one to two months in the oral cavity (14 cases). Chronic inflammations were

scored but with a low rate (6 cases). Only two cases showed no reactions. For a period of more than two months, no acute inflammation was recorded, but chronic inflammations (2cases) and candidiasis (1case). However, fibrosis and ulcerations were independent from the time span as recorded in periods less than 2 months and in a case of more than 3 months (1 case of fibrosis).

**Conclusion:** The histological analysis of gingiva surrounding polymethyl methacrylate provisional restorations fabricated directly in the oral cavity proves that it may induce various gingival reactions despite the exceptional absence of any tissular reaction in some cases. This corroborates the in vitro studies demonstrating the cytotoxicity of these materials

## INTRODUCTION

For teeth which need restoration by fixed prostheses, gingivectomy is a surgical procedure proposed whether for patients who are present with short clinical crowns leading to poor retention or to improve esthetics in patients with uneven gingival margins and excessive gingival display. Potential drawbacks of surgical procedures included fracture or crack initiation and propagation in weakened residual tooth structure and arbitrary gingival recontouring. [1]

Therefore, when planning esthetic crown lengthening in such cases, usually it is proposed to start by a crown preparation which is subsequently provisionalized to enhance the tightness of endodontic treatment, to protect the residual tissues, and to be used as an index for the surgeon to locate the new margin situation. These interim restorations will be directly relined to fit the preparation that had been finalized during the surgical phase.[1]

Nevertheless, most dentists use the direct technique because it costs less and it eliminates the intermediate laboratory procedures. These temporary crowns are used during the tooth

preparation till the placement of definitive crowns. [2][3]The temporization period differs from one case to another, and is dependent on many factors, such as patient availability, multidisciplinary treatment, laboratory procedures.[3][4][5]

However, methyl methacrylate acrylic resins are often used materials in dentistry[6] because of their low cost, and their ease of use. They are likely mentioned in the literature as potentially traumatizing the tissues because of the polymerization reaction exposing the tooth structure to heat [2][3] and cytotoxic acrylic resin monomer. Vallittu confirmed these materials as heat producing, and the increase of the peak temperature was related to the amount of acrylic resin, and if this peak overcome the physiological heat dissipating mechanisms of the dental periodontal system, this will be harming to the surrounding oral tissues and damaging for odontoblasts if transferred to the pulp [7]. This leads to various histo-pathologic changes, including formation of “blisters”, ectopic odontoblasts and their destruction[3].

Thus, the use of a matrix acting as a heat sink has been suggested to hold the commonly used resins.

Both poly-vinyl siloxane materials and irreversible hydrocolloid have been described in several studies to significantly reduce peak polymerization temperature. [2]

Meanwhile, many reports on the biological consequences became widespread because of the residual monomer, and some components such as phthalates esters, formaldehyde[5] which diffuse out of the prosthesis and go into the adjacent oral tissues, resulting in an irritation, inflammation, and allergic reactions. [20] Moreover, this explains how oral tissues in direct contact with in situ polymerized resin may suffer higher concentrations of chemicals that will lead to greater tissue damage, confirmed by biocompatibility tests where the cell reactions can be described morphologically or quantitatively based on cell viability, proliferation and cell function such as apoptosis adhesion, migration and secretion of certain substances [5].

Further investigations on biocompatibility indicated that the candida albicans are more adherent species to plastic surfaces and the mucosa of the oral cavity than the other candida species [8]. Chemical and physical properties of resin based restorations lead to a well environment for candida albicans which is widely known to adhere not only to intraoral tissues but also to dental materials. Rough surfaces is a factor of microorganism entrapment [9].

Although, numerous studies have dealt with the biological effects of methyl methacrylate, there is a paucity of research concerning the histological changes in the periodontal tissue contouring direct

provisional restorations. It has been proved that unreacted monomer caused soft tissue irritancy, [20] especially on the fitting surface mucosa [5]. Expect an in vivo study about tissue compatibility of methyl methacrylate resins in cranial prostheses which reported minimal inflammation after the third week and the microscopic findings of tissue biopsies were consistent with the reparative stage of wound healing. The histological findings were studied to up to 12weeks [10]. Few findings demonstrated in vivo tests assessing the effects of resin based restoration on oral mucosa, they recorded lichenoid reactions, epithelial proliferation, and mucosal irritations.[20] However, human gingival fibroblasts have been frequently used to test the biocompatibility of dental materials [5, 6, 11]. Their relative merits are that they can be easily isolated from patients and can grow fast in normal culture medium, also they show high sensitivity in cytotoxicity tests.

None of the reported research demonstrated in vivo histological findings on the surrounding interim restoration tissue according to the time span of provisionalization. However, increasing concerns about the biocompatibility of methyl methacrylate resins remain evident because of their use in dentistry.

This article describes: 1. the possible effects if methyl methacrylate temporary restorations on the surrounding soft tissue. 2. a histological investigation thanks to utilizing the gingival band obtained after gingivectomy indicate for esthetic requirements. 3. histological findings correlated with the time span of temporization.

## MATERIAL AND METHODS

Participating patients were those who presented to the dental clinic for fixed restoration. They were esthetically demanding and agreed to provide written informed consent so no ethical problem. Inclusion criteria included patients aged between 20 to 60 years old, with non-contributory medical history, showing good oral hygiene with healthy periodontium and a band of 3mm at least of attached gingiva was present. When a patient presented uneven margins, and gingivectomy was indicated to harmonize gingival display, he was invited to participate in the study. After gingivectomy, the gingival fragment surrounding the provisional restoration was saved to be histologically analyzed. Patients were excluded when not demanding esthetics or under medications or reporting health problems with present caries on the concerned tooth. All recruited patients in the clinical department underwent complete plaque and calculus removal before prosthetic treatment. The preparation was done smoothly not to impact the periodontal tissue. Polyvinyl siloxane matrix were already prepared on the waxed diagnosis casts and used to perform the provisional restorations directly on prepared teeth as it absorbs the heat produced. Polymethyl methacrylate resin was used respecting monomer/polymer ratio in accordance with manufacturer's recommendations. Then external cooling with air or water spray during intraoral polymerization was used to avoid undue heating to the pulp and surrounding tissues. The provisional crown was removed from the prepared

tooth prior to the complete curing stage was cooled and then resealed.

Margin fit, occlusion, contours, embrasures and contact areas were adjusted. When these restorations were evaluated for adequate shape and function, they were then mechanically polished using abrasive papers, and slurry of medium grit pumice mixed in a 1:1 ratio of water was used with cloth wheel on the polishing lathe. This was repeated with fine grit pumice. A second cloth wheel, high shine buff was then used with polishing brown Tripoli.

The provisional restorations were seated with a temporary cement [no eugenol based temporary cement]. Then, the patients were recruited for gingivectomy and surgical appointments were programmed.

The appointment depended on the availability of the patient, and the clinical situation. So, the span time of temporization was so different. Some patients were dismissed and came after one month or more.

This allowed a histological assessment of periodontal tissue surrounding provisional restorations correlated with the time of temporization.

After giving anesthesia, gingivectomy was carried out. The surgical procedure was aimed at re-establishing the harmony of the margins and/or for crown lengthening exposing more tooth structure. Provisional restorations were as an index for the surgeon piloting a correct gingival recontouring. The saved gingival band surrounding the

provisional restoration was utilized and microscopically analyzed.

In post-surgery period, temporary crowns were used, relined, and seated until there has been full healing and the gingival margin was in stable position.

All gingival bands were fixed in a 10% buffered formal for histological analysis, included in paraffin, and examined over sections of 5 microns colored with hematoxylin-eosin. A specific coloration with schiff periodic acid [SPA] was performed for several bands to search for associated mycosis.

## RESULTS

Histological exams consisted on a microscopic observation, and a description of the gingival mucosa and pathological changes which appeared according to different time span of temporization.

In terms of pre-prosthetic treatment and the availability of patients, 20 provisional restorations were placed in the oral cavity for less than one month, 4 provisional restorations between 1 to 2 months, 4 provisional restorations between 2 to 3 months, and 2 provisional restorations for more than 3 months.

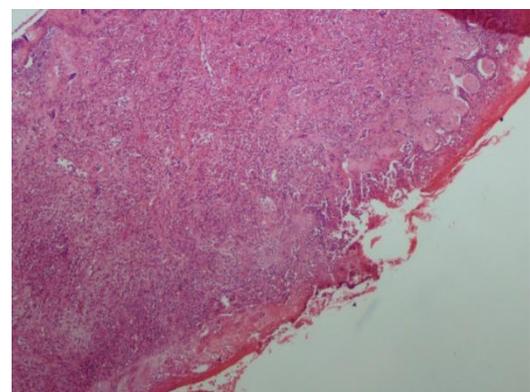
The most marked tissue alteration was inflammation with 14 cases of acute inflammation, 8 cases of chronic inflammation. Other histological variations were noted like ulceration, fibrosis and candidiasis.

Correlation between the period of placement of immediate temporary prostheses and the different histological alterations were made.

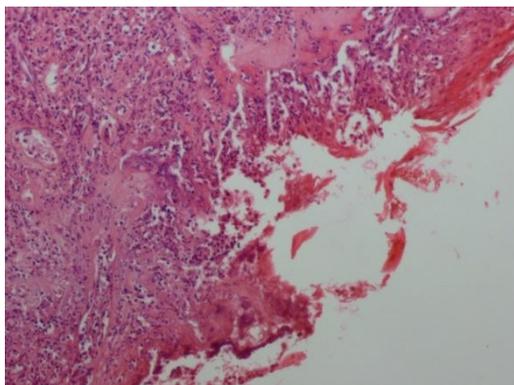
When temporary prostheses were left in place for a short period, inflammation was the frequent lesion observed with its two forms (acute or chronic]. For a long lasting provisional restorations, candidiasis appeared. Fibrosis and ulceration were not time depending.

## DISCUSSION

The high rate of acute inflammation in the gingiva surrounding provisional restorations correlated with temporization periods of less than 2 months may be explained by exothermic reactions exhibited by temporary resins. Castelnuovo in 1997 proved that the elevation of temperature due to the chemo polymerization of resins could induce pulpal damage when provisional restorations are performed directly in the oral cavity [12]. Despite cooling procedures, the use of silicone matrix to absorb heat [2], as well as the presence of periodontal ligament known as heat dissipating[12], periodontal reactions may be manifested as acute inflammation in most of the cases and sometimes ulceration [fig1 and2].



**Fig 1:** Acute inflammation and ulceration of the surface epithelium: very inflammatory widely ulcerated mucosa.



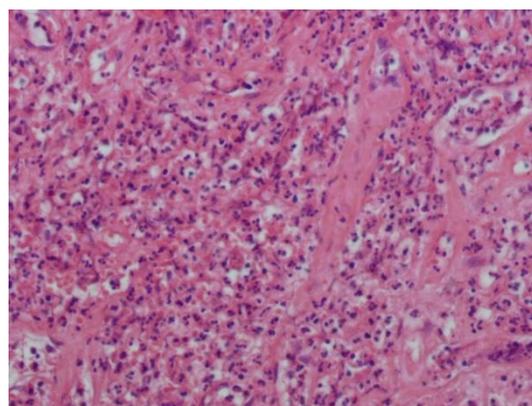
**Fig 2:** The same blade: ulceration of the mucosa at a higher magnification.

The highest number of acute inflammation was found during periods of temporization of less than 2 months, may be also explained by the highest amount of residual monomer of methyl methacrylate which is especially released in the oral mucosa during the first 24 hours after processing proved by Baker et al on the salivary film on the fitting surface contains monomer released in the saliva[13]. However, for provisional restorations existing in the oral cavity for more than two months, no acute inflammation was recorded in favor of chronic inflammation proving that acute response may be related to the high concentration of toxic residual monomer.[13][20] Then, other possible reactions are probably related to continuous leachability of monomer corroborating with Sadamori et al 1992[14], in case of autopolymerized appliances, where the higher release of residual monomer was scored for 5 years after processing with a possibility to continue up to many years.

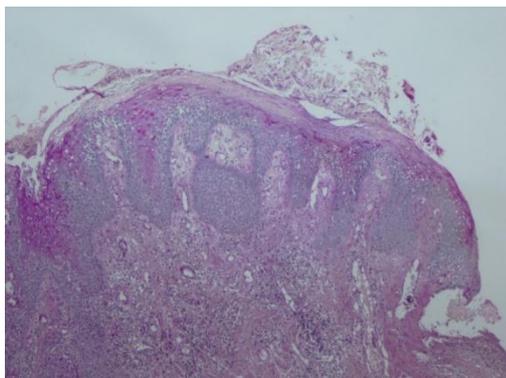
Chronic inflammations recorded for provisional restorations seated in mouth for more than one month may be related to the biodegradation process of resinous materials depending on

chewing, and dietary changes, [4][20] causing then the release of toxic substances, other than MMA, such as benzoic acid, phthalates, dibutylphthalate, as well as formaldehyde[15]. The latter was determined as a higher toxic than MMA even with lower amount [16]. This may also explain the presence of ulceration correlated with longer time span. The presence of polymorph inflammatory infiltrate associating lymphocytes, plasmocytes, neutrophilic and eosinophilic polynuclears[fig 3] may be associated with MMA cytotoxicity as proved by UrepornKedjarune[11][1999] who showed that leucocytes demonstrated marked signs of cytotoxicity when treated with MMA.

Possible transition of acute to chronic inflammation may rapidly occur for certain cases. This may explain the early chronic inflammation marked for temporization of less than one month [fig4].



**Fig 3:** details of chorion infiltrate: rich in polynuclear neutrophils.

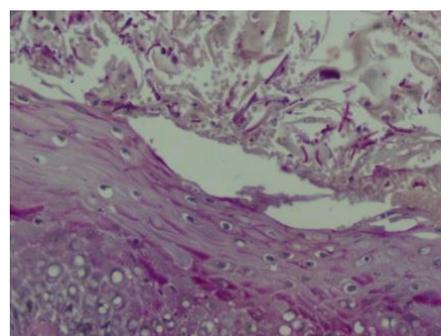


**Fig 4:** Acute and chronic inflammation of the mucosa with acanthosis of the surface epithelium and hyperparakeratosis : special coloration with SPA showing a surface erosion.

Although, various tissue reactions were correlated to the time span of resinous provisionalization, some cases which didn't depend on the period of the time didn't show any histological reactions or modifications, and may be explained by saliva concentrations which differs for patients. This corroborates with in vitro studies which has shown that the salivary pellicle on the crown surface could form a barrier to diffusion and oxidative enzymes such as myeloperoxidase in saliva might also be involved in the degradation of MMA probably hydrolyzed in saliva inhibiting thus any inflammation process[13]. However, the decrease of acute inflammation is explained by the evaporation of monomer with time, as well as hydrolysis of PMMA demonstrated by S Baker[13] in an in vivo study.

The variations between acute, chronic inflammation and ulceration may be due to minor irregularities of some provisional restorations which can provide a source of irritations. Thus, correlating the presence of chronic inflammation and ulcerations with periods of 2 to 3 months, the

relationship may be explained by intraoral conditions that can alter the structural integrity of methyl methacrylate based provisional restorations [4] despite a strict polishing before intraoral seating[17]. Rougher surfaces can cause discoloration of the prosthesis and contribute to microbial colonization and biofilm formation bacterial and fungal species have more of a propensity to adhere to rough prosthetic material [8]. This phenomenon, possibly, explain the candidiasis found in one case of long lasting provisional restorations in the oral cavity, and microscopically defined by the presence of mycelian filaments among lost substances [fig5].



**Fig 5:** Same blade showing mycelian filaments to SPA colorations included in the loss of substances.

*Candida albicans* adheres more to rough surfaces much more than polished surfaces [18]. *Candida albicans* is colonize on the prosthetic materials, especially acrylic resins, as well as the oral tissues [19]. It may arise from surface roughness or oral hygiene. However, the exact mechanism by which *C. Albicans* affixes itself to these surfaces has been substantiated with the ability of *candida albicans* to adhere to polymeric surfaces, and has

been correlated with attractive hydrophobic and repulsive electrostatic forces[8].

Whereas, fibrosis associated with focal gingival abrasion could be one of the possible reactions to resin cytotoxicity [fig6]. Y.L.Lai et al[6] studied the cytotoxicity effects of MMA in vitro and proved that a portion of fibroblasts died from apoptosis.



**Fig 6 :** Focally abraded gingival mucosa with chorion fibrosis.

These investigations compared to in vitro studies confirm the cytotoxicity of resins provisional restorations especially when directly performed in the oral cavity. These reactions may be complicated by candida albicans adherence to resin surfaces. Acute gingival irritations are mostly manifested in the first weeks of seated provisional restorations. The absence of reactions in few cases may not exclude the cytotoxicity of MMA to gingiva as many factors and phenomena may be related to these tissular reactions.

**Table 1: Span time of the temporary prostheses**

	Number
<1month	20
Between 1 to 2 months	4
Between 2 to 3 months	4
>3months	2

**Table 2: The type of histological lesions observed**

	Number
None	2
Acute inflammation	14
Chronic inflammation	8
Ulceration	2
Fibrosis	3
Candidiasis	1

**Table 3: Relationship between duration of placement of the provisional prostheses and histological lesions observed**

	Different lesions observed	Number
<1month	None	1
	Chronic inflammation	5
	Acute inflammation	12
	Ulceration	1
	Fibrosis	1
Between 1 to 2 months	Chronic inflammation	1
	Acute inflammation	2
	Fibrosis	1
Between 2 to 3 months	None	1
	Chronic inflammation	2
	Ulceration	1
>3months	Fibrosis	1
	Candidiasis	1

**CONCLUSION**

The histological findings prove that cytotoxic potential of polymethyl methacrylate chairside made provisional restorations may include various gingival reactions taking into consideration other possible factors involved in these tissular reactions. These provisional restorations should be performed with more precautions and shouldn't be kept in the oral cavity for long periods.

### Conflict of Interest Statement

The authors declare no conflict of interest for this study.

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