CONTROL AND REDUCTION OF PEAK TEMPERATURE IN SELF-CURING RESINS

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SUMMARY

Control and reduction of peak temperature in self-curing resins.

Introduction. The aim of this experimental study was to reduce the exothermic reaction during curing of the resins to cold. The significant exotherm generated by the reaction of polymerization of the resin curing involves many clinical complications including the high risk of necrosis against tooth.

Material and methods. They were used four different types of self curing resins all based on methyl methacrylate, Jet Kit, Major Dentin, Dura Lay, Temporary Cold. The reaction of polymerization of the resins was done in Teflon pans and was monitored by a thermocouple which recorded the highest level reached by each temperature resin with and without additive. The polymerization reaction took place for each resin in the presence of an essential oil, the terpinolene, which acted as a "chain transfer" and different temperatures were recorded.

Results. Resins Dura Lay and Jet kit showed a reduction of very high temperature in the presence of terpinolene, with a statistically significant difference compared to the same reaction without terpinolene Major resin dentin in the presence of the additive has reduced by 8.4°C peak temperature. Resin Temporary Cold has showed benefits with respect to peak temperature, but the reaction was much more 'consistent presence of the additive.

Discussion. The system through which the chain transfer acts to lower the temperature of the reaction is that of chain transfer. Namely that interfere with the reaction of the polymer chains, by transferring these acrylic radicals are no longer active, ie, no longer able to bind to other monomer units, thus avoiding the excessive growth of macromolecules which are those that determine the temperature rise. This leads to the formation of more polymer chains with lower molecular weight.

Key words: peak temperature, polymerization, resins.

RIASSUNTO

Controllo e riduzione del picco termico nella polimerizzazione delle resine a freddo.

Introduzione. Lo scopo di questo studio sperimentale è stato quello di ridurre la reazione esotermica durante la polimerizzazione delle resine a freddo. La notevole esotermia generata dalla reazione di polimerizzazione delle resine autopolimerizzanti comporta numerose complicanze cliniche tra le quali l'elevato rischio di necrosi a carico dei denti vitali.

Materiali e metodi. Sono state utilizzate quattro diversi tipi di resine autopolimerizzabili tutte a base di metilmetacrilato, Jet Kit, Major Dentine, Dura Lay, Temporary Cold. La reazione di polimerizzazione delle resine avveniva in vaschette di teflon e veniva monitorata tramite una termocoppia che registrava le temperarure massime raggiunte da ogni resina con e senza additivo. La reazione di polimerizzazione è avvenuta per ogni resina anche in presenza di un olio essenziale, il terpinolene, che agiva da "chain transfer" cioè traserimento di catena e venivano registrate le differnti temperature raggiunte.

Risultati. Le resine Dura Lay e Jet Kit hanno mostrato una riduzione di temperatura molto elevata in presenza del terpinolene, con una differenza statisticamente significativa rispetto alla stessa reazione senza terpinolene La resina Major Dentine in presenza dell'additivo ha ridotto di 8,4°C il picco termico. La resina Temporary Cold non ha mostrtao benefici in relazione al picco termico, ma la reazione è risultata molto più omogenea in presenza dell'additivo.

Discussione. Il sistema attraverso cui il chain transfer agisce determinando un abbassamento di temperatura della reazione è quello del trasferimento di catena. Ovverosia questo interferisce nella reazione delle catene polimeriche, trasferendo a queste radicali acrilici non più attivi, cioè non più in grado di legarsi ad altre unità monomeriche, evitando così l'eccessivo accrescimento delle macromolecole che sono quelle che determinano l'incremento della temperatura. Tutto ciò porta alla formazione di più catene polimeriche con minor peso molecolare.

Parole chiave: picco termico, polimerizzazione, resine.

Introduction

The use of acrylic resins in dentistry is very large, particularly in prosthetic field where they are used in particular in the creation of temporary crowns and removable partial dentures (RPD).
The temporary crowns are required before definitive crown and perform different functions: to protect the polished tooth, preventing occlusal migration, reduce tooth sensitivity and ensure an acceptable appearance (1). The RPD will be made for those patients who need to rehabilitate the edentulous arch. There are two systematic rebases for this type of prosthesis: direct and indirect. The indirect method is more accurate and allows for protection of particular oral tissues, but time constraints and necessary laboratory support mean that the direct method is still much used today.
One of the disadvantages of the direct method is the exposure of oral tissues, the heat generated by polymerization. In the transition from liquid phase to plastic phase, the resin polymerizes, ie the formation of polymeric macromolecules from smaller molecules called monomers, this process is known as chemical polymerization, highly exothermic reaction.
The large amount of heat emitted during the polymerization can cause serious problems at the expense of vital tissues, such as the relining of temporary crowns. The pulp is vulnerable and can be damaged during the preparation of the stump (2-3), or during construction of temporary (4, 5-9) heat can create an insult to the pulp as chemical exposure, drying (3) and bacterial infection. It been demonstrated to be a sufficient increase in temperature of 5.6°C to determine pulpal necrosis of 15% at 11°C will have approximately 60% of necrosis to achieve an increase in temperature up to 16.6°C, which leads to 100% pulp necrosis (10).
The purpose of this study was to reduce the exothermic reaction generated by the polymerization of methacrylate with the addition of an additive.
The null hypothesis was that there is no temperature difference between the polymerization with and without additive.

Material and methods

Been used four different types of self-curing resins all based Polymethylmethacrylate.
For each resin, we measured at defined time intervals, the evolution of the thermal polymerization reaction. A thermocouple [A] (HI 98701) connected to a digital monitor was used to record changes in temperature of the resins during polymerization.
The four resins tested are as follows: Jet Kit[B], Major Dentin[C], Temporary Cold[D], Dura Lay[E]. The phase mixing of the liquid with the powder took place in small pans, Teflon, insulating material, in order not to dissipate heat, and measure the peak temperature of each resin.
The thickness of the trays was 6 mm and the radius of 3 cm.
For each resin were used the same quantity of powder and liquid, respectively 4GR and 1.5 g. The same reaction with the same amount of powder and liquid forms has taken place with the addition

Figure 1
Resort-Thermocouple, probe, Teflon.

[A] Thermometer thermocouple type K, J, T with built-in printer Hanna Instuments 98701
[B] Jet Kit Lang Dental MFG Co Wheeling, IL 60090 USA
[C] Major dentine Major Prodotti Dentari Spa 10024 Moncalieri IT.
[D] temporary.cold.v Major Prodotti Dentari Spa 10024 Moncalieri IT.
[E] DuraLAy Rliance Dental Mig. Co. Worth, IL 60482 OZ.

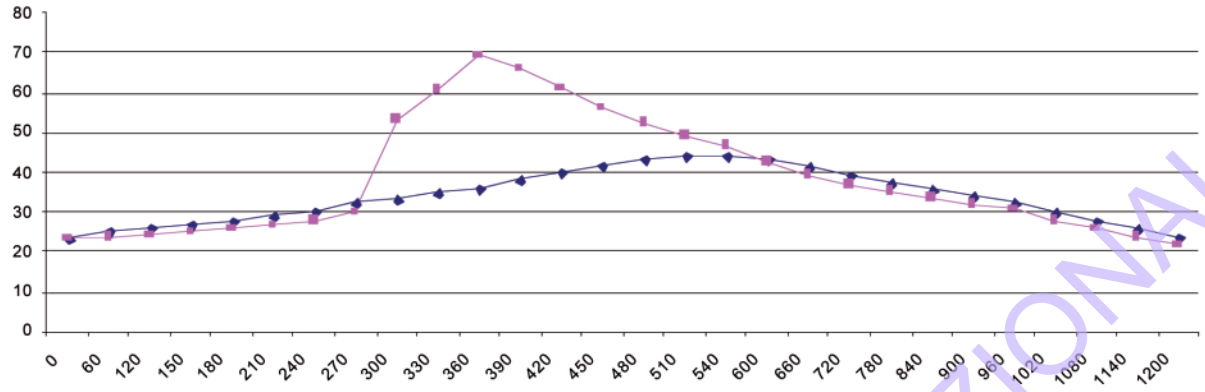

Figure 2
Reaction of polymerization of the resin Dura Lay. On the y-axis shows the temperature in degrees Celsius. On the x-axis shows the time in seconds.

of a regulator in the chemical reaction known as "chain transfer", this is an essential oil extracted from terpene, the terpinolene [F].
The quantity of terpinolene added to the powder and the liquid before mixing was 0.05 g.
The system through which the chain transfer acts to lower the temperature of the reaction is that of chain transfer. Namely that interfere with the reaction of the polymer chains, by transferring these acrylic radicals are no longer active, ie, no longer able to bind to other monomer units, thus avoiding the excessive growth of macromolecules which are those that determine the temperature rise. This leads to the formation of more polymer chains with lower molecular weight.
The addition of this additive does not change the toxicity of methyl methacrylate, since this is a natural product, in the case of an essential oil.
Polymerization reactions of all the resins have been reported on three-dimensional histogram graphs, which show clearly the stages of major exothermic.

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Results

The chart shown below (Fig. 1) refers to the reaction of the resin Dura Lay, where the abscissas are the values in seconds and the ordinates degrees centigrade. The histogram in purple represents the classical polymerization with a temperature of 69.4°C, as the sixth minute after mixing.
The histogram in gray instead configures the reaction with the addition of 0.05 g of chain transfer. You can see that the polymerization reaction by first maintaining a more uniform pattern without sudden peaks and reaching a maximum temperature of 44.4°C after nine minutes.
The second graph (Fig. 2) depicts the reaction of the resin Jet Kit, the curve of violet's histograms very violent and the temperature is considerably higher than the gray curve which represents the resin with the addition of chain transfer, which has maintained The lower temperature of 24°C above the resin without the additive.
In the third graph (Fig. 3) depicts the reaction of polymerization of the resin dentin Major, here particularly the more visible than in the previous graphs the effect of the fact by the gray line (represented by the reaction in the presence of additive) is shows that the polymerization start right away then to keep a constant rate until it reaches a temperature of less than 8.4°C above the standard resin.

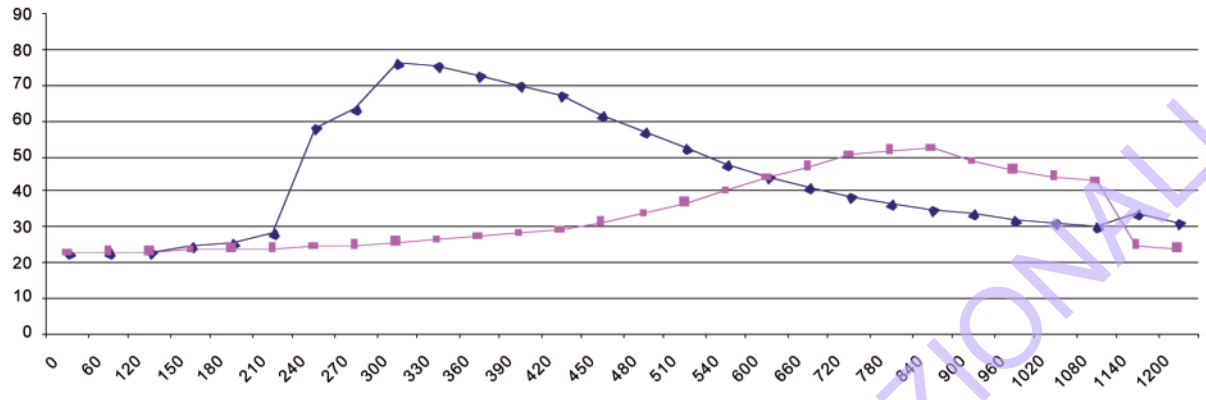

Figure 3
Reaction of polymerization of the resin Jet Kit. The maximum temperature reached was less than 20°C in the presence of terpinolene.

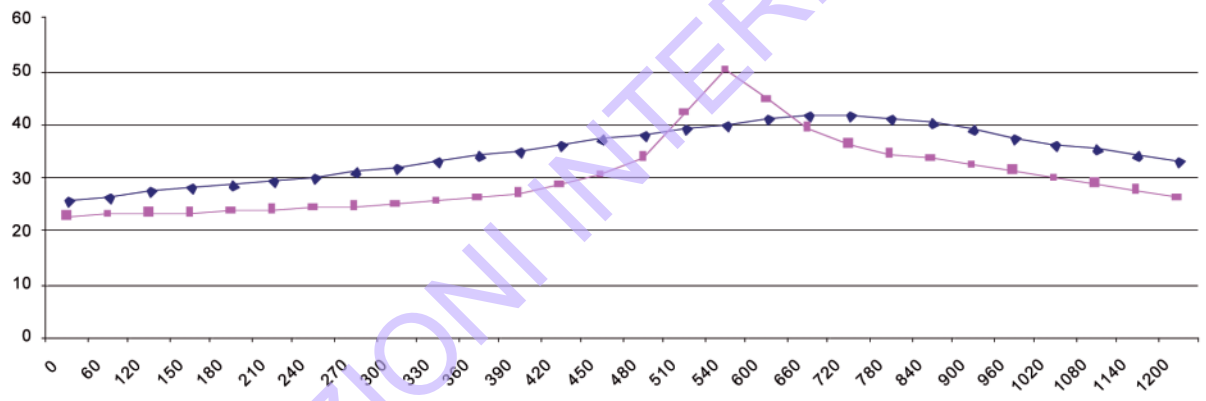

Figure 4
Reaction of polymerization of the resin Dentine Major. Note that the exothermic reaction is more homogeneous in the blue line, which represents the resin in the presence of terpinolene.

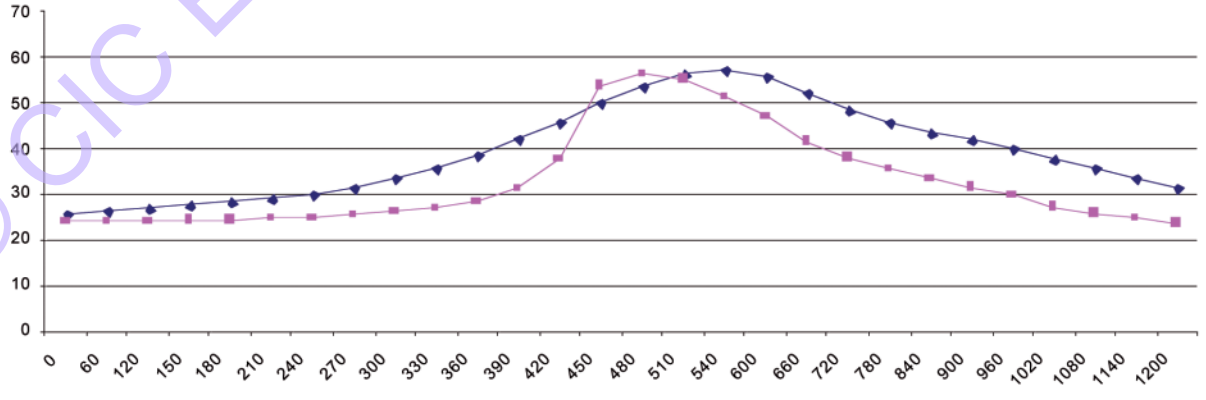

Figure 5
Reaction of polymerization of the resin Temporary Cold. In this case the maximum temperature recorded was obtained although we are in the presence of terpinolene, a difference of 0.8°C.

Table 1 - Are presented in this table, the maximum temperatures recorded during the curing of different resins in the presence ($T°C_{max}$ + CHAIN TRANSFER) and in the absence of ternpinolene ($T°C_{max}$), time at which it reaches the peak temperature (TIME) and finally, the difference in tepmerature ($\Delta T°C_{max}$).

RESIN	$T°_{max}$	TIME	$T°^{max}$ + CHAIN TRANSFER	TIME	$\Delta T°_{max}$
DURA LAY	69,4°	6′	44,2°	9′	25,2°
JET KIT	76,2°	5′	25°	16′	24,2°
MAJOR DENTINE	50,3°	9′	41,9°	11′	9,2°
TEMPORARY COLD	56,5°	8′	57,3°	9′	-0,8°

The fourth and final graph (Fig. 4) shows the reaction of the resin Temporary Cold (Major), where we see the different trends of the two curves while getting almost the same final temperature, even though we were in the presence of additive the temperature reached is was higher than 0.8°C (curve in gray), but we see that the reaction in the presence of the additive is much less violent, resulting in a very small change in temperature from a peak heat that develops in the absence of chain transfer (purple histogram).

Statistical Analysis

Test to assess the normal distribution and homogeneity of data: respectively One-Sample Kolmogorov-Smirnov Test ($p > 0.01$) and Levene's test omogeneity ($p > 0.05$).

Tests comparing average: Independent Samples T Test ($p < 0.05$).

The statistical analysis of data analyzed shows that there is a statistically significant difference between the resin Dura Lay and Jet kit with and without additive. There is no statistically significant difference between the other two groups (Tab. 2).

Discussion and conclusion

The null hypothesis was rejected, since two out of four samples showed a statistically significant difference.

Consistent with this in vitro study, the exothermic reaction during polymerization of reisin three out of four showed a clear reduction of peak temperature in the presence of regulator response, terpinolene. The system through which the chain transfer acts to lower the temperature of the reaction is that of chain transfer. Namely that interfere with the reaction of the polymer chains, by transferring these acrylic radicals are no longer active, ie, no longer able to bind to other monomer units, thus avoiding the excessive growth of macromolecules which are those that determine the temperature rise. This leads to the formation of more polymer chains with lower molecular weight.

The addition of this additive does not change the toxicity of methyl methacrylate, since this is a natural product, in the case of an essential oil.

The exotherm generated by the polymerization during the relining of the temporary crown is one of the risk factors for pulpal damage.

To reduce the effect of the exotherm generated by this reaction, some authors have suggested the use of water.

Other authors (11) suggest use air or removing the temporary crown at the beginning of polymerization, the prepared tooth.

Obviously the amount of heat produced by the exothermic reaction of provisional resins appears to

Table 2 - Different letters highlighting the groups where there is a statistically significant difference.

	Dura lay	Jet kit	Major	Temporary
No Add	44 (0,35) ***A***	71,73 (7,22) ***A***	45,70 (4,16) ***A***	55,13 (1,40) ***A***
Add	65,4 (4,39) ***B***	50,77 (1,88) ***B***	41,63 (0,31) ***A***	56,53 (0,68) ***A***

be dependent on the amount of the material used. A larger amount of material obviously generates more heat and higher temperatures to increase proportionally to the tooth during polymerization (12, 13). The transition from plastic resin to the solid phase must necessarily take place in the oral cavity, because the interim must be modified as needed anatomical preparation of the stump and this means a considerable increase in temperature to load the oral tissues, especially in charged to the stump, when vital, may suffer irreversible damage.
This study showed that the addition of the additive has reduced the peak heat, thereby reducing the risk of pulpal damage.

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