Protemp™ 3 Garant™
Temporary crown and bridge material

Technical Product Profile
Preface

Temporary crown and bridge restorations are an indispensable yet demanding interim solution which call for high-quality materials and great care on the part of the dentist.

Due to the clinical and technical procedures involved, crown and bridge restorations require several distinct treatment phases for completion. Thus, a temporary restoration is needed for the interim phase. In the past, the functional aspects of a temporary restoration predominated, while today’s materials also have to cater to the increased demands placed on aesthetics and economy – a difficult balance to achieve. The rapid evolution of aesthetic restoration materials such as ceramics and composites has been accompanied by improvements of temporary materials. Nowadays, a large number of suitable temporary materials are available for the fast and effective restoration of prepared teeth.

As early as 1968, ESPE pioneered the development of composite-based temporary crown and bridge materials. Over time, ESPE’s product development yielded continuously improved materials offering superior mechanical properties, reduced polymerization heat as well as a more precise fit and color stability.

With 3M™ ESPE™ Protemp™ 3 Garant™, a further milestone has been achieved. This class of material features greatly improved fracture resistance without any compromises in terms of the tried and tested product benefits. This innovation is rounded off by a new cartridge system with enhanced handling characteristics.

<table>
<thead>
<tr>
<th>Year</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1968</td>
<td>Scutan (Composite with organic PMMA fillers)</td>
</tr>
<tr>
<td>1982</td>
<td>Protemp (Composite with inorganic glass fillers)</td>
</tr>
<tr>
<td>1989</td>
<td>Protemp II (Improved handling)</td>
</tr>
<tr>
<td>1994</td>
<td>Protemp Garant (Automatic cartridge system)</td>
</tr>
<tr>
<td>1997</td>
<td>Protemp II/Protemp Garant (New colors)</td>
</tr>
<tr>
<td>1997</td>
<td>Protemp Garant (New formulation)</td>
</tr>
<tr>
<td>2001</td>
<td>Protemp 3 Garant (Substantially increased resistance to fracture)</td>
</tr>
</tbody>
</table>

Table 1: Composite-based temporary crown and bridge materials available from 3M ESPE
Introduction

The functions which a temporary restoration must fulfill are wide-ranging and demanding. They basically correspond to those of the final restoration, albeit only for a limited period of time. This also applies in principle to teeth whose pulp is dead, while here the biological relevance of dentine contact can be disregarded. Certain compromises in terms of the aesthetic impression are both normal and acceptable, although this aspect is becoming increasingly important from the patient’s viewpoint. Where problematic adjustments regarding aesthetics, phonetics and masticatory functions are concerned, a restoration which can be modified within certain limits is of diagnostic and prognostic value alike in assessing the planned final restoration.

The quality of the restoration not only depends on the quality of the materials provided, but also on the workmanship of the surgery or laboratory and cooperation on the part of the patient as regards hygiene.

The following basic requirements can be listed for temporary restorations:

- For the success of the subsequent prosthetic restoration, it is essential for the prepared teeth to maintain or re-establish their position relative to adjacent teeth and antagonists, and for a temporary restoration to offer sufficient resistance to masticatory forces (diagnostic and masticatory functions).
- To ensure protection for periodontal regions, high requirements have to be stipulated for exact marginal fit, polishability and biocompatibility to rule out consequential damage to the gingiva and bone.
- Restorative dentistry calls for materials which represent no risk to the dentine wound during treatment and avoid further irritation of the pulp (pulp protection function and anti-caries prophylaxis).
- To ensure up-to-date oral prophylaxis, it is important to maintain hygiene: where possible, the patients should have the opportunity to clean their temporary restorations like normal teeth.
- For the patient, the appearance of the restoration plays an important role, i.e. aesthetics and satisfactory phonetics. In a word, minimization of the physical and psychological impairment while the restoration is in place.
- For the dentist, who is called on to produce a high-quality, perfect and modern restoration, benefits in terms of hygienic handling, less demanding technique and rapid completion of treatment are also becoming increasingly vital.
History

The oldest group of polymer-based direct temporary materials are the MMA / PMMA resins. Here, PMMA microbead powder is mixed with monomer liquid and bonded with polymerized methyl methacrylate. The importance of these materials continues to decline, not lastly due to their numerous shortcomings. Their high level of monomer release should not be underestimated, in particular when regarding the application to the freshly prepared tooth using the direct technique. A highly exothermal reaction during setting requires the early removal of the temporary restoration from the preparation. This predisposes to the problem of unsatisfactory fit due to the subsequent polymerization shrinkage. However, the low price and good color stability guarantees PMMA materials a limited market share, albeit with a declining tendency.

Materials made of still monofunctional acrylate monomers with a higher molecular weight have been developed to eliminate some of the disadvantages of polymethyl methacrylate compounds. This also involves powder/liquid systems which have to be mixed by hand and consist, for example, of mixes of polyethyl methacrylate powder and i-butyl methacrylate liquid. A lower setting temperature and, in comparison with PMMA materials, slightly enhanced mechanical strengths are offset by very poor aesthetics and a low resistance to masticatory forces. In addition, these restorations are attacked by cements containing eugenol, something which is of disadvantage particularly in the field of temporary restorations.

The newest and also most successful class of material on the market is the group of bisacrylate composites. Comparable with composites used for definitive restorations, these materials consist of an organic matrix and inorganic fillers. Monomers such as bisphenol-A-glycidyl methacrylate (bis-GMA), triethylene glycol dimethacrylate (TEGDMA) or similar monomer systems derived from Bowen resin are used in the organic polymer matrix. The inorganic fillers account for approx. 40 per cent by weight in the paste. The introduction of the bisacrylate systems for temporary restorations resulted for the first time in the availability of materials with improved mechanical properties, a lower setting temperature and reduced polymerization shrinkage as well as good color stability and polishability. When the hand-mix versions (paste / paste) were supplemented by automix-cartridge systems in the early 90s, it also became possible to satisfy the demands for simple, clean and fast handling. However, the fracture resistance of these materials still merits improvement. Unfortunately, high mechanical strength also comes hand in hand with brittleness. In daily dental practice, this manifests itself in fractures or chipping at the margin during finishing or masticatory stresses: an unpleasant and troublesome phenomenon for dentists and patients.

With 3M™ ESPE™ Protemp™ 3 Garant™, a further milestone in the field of temporary restorations has now been reached. A material with dramatically improved resistance to fracture and very low fracture rates under load is available today.
**Motivation**

With a market share of 75% (Germany), the bisacrylate composite materials have firmly established themselves with practitioners in the field of temporary restorations – not lastly due to their favorable characteristics in terms of mechanical strength, comparatively low setting temperature and polymerization shrinkage as well as good color stability and polishability, while at the same time offering handling advantages in the surgery.

There are calls for improvement as regards the resistance to fractures and fracture rates. This improves the quality of life for the patient while the restoration is in place and reduces troublesome repair work by the surgery staff. The demand for temporary restorations with greater fracture resistance is also reflected in a large-scale market study. Here, a low fracture rate and simple correction and repair were described as the most important criteria for a temporary restoration material. In addition, it should also ensure a low setting temperature, high levels of precision and fit as well as good biocompatibility.

3M™ ESPE™ Protemp™ 3 Garant™ has been developed to meet these needs. An **innovative monomer system** combines high flexural strength and high flexural resistance (characteristic value: elastic modulus) with high elongation at break which permits brief deformation yet guarantees complete recovery. This results in a matrix which can accommodate brief peak forces without fracturing. Stable occlusion, reliable proximal support and protection of the periodontium and abutment teeth are achieved by the material’s high mechanical strength.

An optimized and also newly developed **initiator system** is responsible for ideal setting. The best possible polymerization process during the handling timescale must firstly provide for an elastic phase of sufficient length but then also result in ultimate hardness of the product as quickly as possible. A highly exothermal reaction is equally undesirable as marked polymerization shrinkage.

Lastly, material characteristics such as surface finish, polishability, aesthetics and stability of the matrix filler system are achieved by **sophisticated filler technology**. This is also reflected in color and dimensional stability while the restoration is in place.

One basic prerequisite for the development of Protemp 3 Garant was therefore that the key feature of increased resistance to fracture and a major reduction in the fracture rate under clinical conditions should not be achieved at the expense of the other material characteristics. On the contrary: the benefits already offered by modern bisacrylate systems over monofunctional acrylates were to be optimized even further. That this has succeeded is shown by the results of intensive cooperation with a large number of universities throughout the world. The subsequent sections will cover a selection of the results on material properties and user experience.
Indikations

3M™ ESPE™ Protemp™ 3 Garant™ is a temporary crown and bridge material for use with the direct technique for

- crowns
- bridges
- inlays
- onlays

It is compatible with all impression materials. It is equally possible to use polyvinyl keys, which permit multiple usage and can be stored as a situation impression (e.g. 3M™ ESPE™ Position™ Penta™ / 3M™ ESPE™ Position™ Penta™ Quick) as well as alginate impression materials (e.g. Palgat™ Plus / 3M™ ESPE™ Palgat™ Plus Quick).

Also suitable are laboratory-made templates or strip crowns for single tooth restoration.

If required, anatomical remodeling can naturally be performed with Protemp 3 Garant after building up the intended additions on the model in wax and capturing them. If an anatomical change in shape is required, the situation can of course also be shown waxed up on the model and then realized using Protemp 3 Garant. In addition, it is also very easy to carry out individualization with 3M™ ESPE™ Sinfony™ both in terms of shape and color at the laboratory, or directly at the chairside, opening up a further range of modeling options.
Chemical background

The chemistry of composite materials

A dental resin is made up of the following main constituents (see also Fig. 1):

- resin matrix / monomers
- initiators
- silanized fillers

The monomers contained in the organic matrix become bonded to each other through a radical polymerization reaction.

With self-curing materials, this occurs when the initiator components come together during mixing of the base paste and catalyst and react with each other in a redox reaction. It produces a radical \( R^\bullet \), which is now capable of attacking the double-bond of an acrylate group and itself generating a radical. This process is called a chain initiation reaction (see Fig. 2).
The chain growth reaction will continue as long as a free radical encounters a double-bond. As the chain is extended – this process represents actual polymerization – molecules of ever-increasing size are formed. Only when two radicals directly encounter each other are they recombined and the reaction finishes in a chain termination reaction (see Fig. 3.) This stops further growth of the chain.

![Chain termination diagram](image)

If a polymer matrix solely consists of monofunctional low-molecular monomers, as is the case with MMA / PMMA materials, only linear chainlike polymers can be formed (see Fig. 3 and 4). Three-dimensional interlacing is only possible through physical looping of the individual polymer strands, and the resulting framework is not very stable. Major disadvantages of polymethyl methacrylates and their higher homologues can easily be concluded from this situation: high polymerization shrinkage, low mechanical stability and relatively high residual monomer detachment. This is also associated with very high elasticity which is however irreversible, taking the form of “cold flow”. This means that the material yields under load but does not recover when the load is removed. The attachment apparatus and the periodontium are traumatized.

![Polymerization diagram](image)
The situation is completely different for **bisacrylate composites**. Here, the monomers are bifunctional, i.e. they contain two double-bonds capable of reacting. Bisphenol-A-glycidyl methacrylate (bis-GMA), triethylene glycol dimethacrylate (TEGDMA) or similar monomer systems are frequently used. 3M ESPE utilizes modified Bowen resins which correspond to derivatives of the bis-acryl compounds that have been rendered hydrophobic. This provides for a major reduction in the water absorption of the materials; the dimensional stability while in place is also improved and discoloration is much less frequent than with the other systems on the market.

The multiple functionality of the monomers already mentioned above ensures the formation of a three-dimensional network, with the structure now being fixed by chemical bonds (see Fig. 6).
The incorporation of the inorganic fillers in the organic matrix is also a chemical process when the fillers are silanized as with 3M™ ESPE™ Protemp™ 3 Garant™ (see Fig. 7). This produces a mechanically stable composite material which is wear-proof, radiopaque and polishable. In addition, polymerization shrinkage is greatly reduced in comparison with the filler-free MMA / PMMA materials. One direct clinical result of this is the good precision of fit of the temporary restorations.

Fig. 7: Chemical incorporation of fillers in the matrix
Special characteristics of 3M™ ESPE™ Protemp™ 3 Garant™

In addition to the favorable characteristics of a composite as already achieved for Protemp Garant, the innovative new development of Protemp 3 Garant also has a few other special features to offer.

At the outset it was mentioned that there is a strong demand for less brittle composites, i.e. materials with a greater fracture resistance but still offering high mechanical strength, in particular for the production of temporary restorations. Another objective is to increase edge strength and marginal stability to achieve thinly tapering and exactly fitting margins without having to expect chipping while finishing and during the wearing period. In material scientific terms, this means that we had to find a material which permits limited deflection that is higher than for standard composites, but does not mimic the behavior of MMA/PMMA materials, which can undergo great deflection but do not recover afterwards. At the same time high flexural strength and high flexural resistance (characteristic value: elastic modulus) are required to relieve the stress on the periodontia. To be recommended are resins with high tensile strength which withstand high stresses until fracture and can also tolerate brief deformation due to high elongation at break while at the same time offering a high elastic modulus.

To cater to this characteristics profile, 3M ESPE has developed a completely new monomer system. It has succeeded in striking a balance between high mechanical strength and limited elasticity of the resulting composite material. For this purpose, monomers were synthesized which do not possess a rigid intermediate chain, as in the case of bis-GMA homologues, but are already flexible in themselves (see Fig. 8). Incorporation in the comonomer matrix and bonding to the fillers takes place, as described earlier, via methacrylate units.

Fig. 8: Flexible chain of monomers in the new monomer system
It was now possible to reduce the three-component initiator system used for 3M™ ESPE™ Protemp™ II to two components. This involves a highly complex chemical system which provides high storage stability, steady setting behavior and color stability. As an indirect positive effect, the inhibition layer has been greatly reduced; the dentist will immediately appreciate this when finishing temporary restorations. Another important clinical aspect is a marked reduction in the generation of heat during the setting of 3M™ ESPE™ Protemp™ 3 Garant™.

Lastly, the Protemp 3 Garant formulation also includes new filler technology. The glass particles used are even finer than before and guarantee a smooth surface structure and good polishability (d50 < 0.7 µm, d90 < 3 µm).

**Individualization and supplementation using Protemp 3 Garant**

When producing temporary restorations there is sometimes a requirement for simple individualization. Both the color adaptation and anatomical changes may play a role here. Protemp 3 Garant has also been optimized in this regard. On the one hand, Protemp 3 Garant can be used as a supplementation material at any time. The option of using the flowable composite 3M™ ESPE™ Sinfony™, which is familiar from the dental laboratory, for finishing work lends even more flexibility. The full range of shades offered by a tried and tested veneering resin is thus now also available for intraoral applications. Sinfony used in combination with Protemp 3 Garant only requires a roughened surface; the additional use of a bonding agent is not necessary.

To sum up, it may be said that Protemp 3 Garant represents a new generation of temporary restoration materials. All components – the organic matrix, initiator system and inorganic fillers – have undergone major improvement. The result is an innovative material that caters perfectly to the requirements of both dentist and patient.
Product composition

Product components

3M™ ESPE™ Protemp™ 3 Garant™ is a two-component paste/paste system which is available in a new double-chamber cartridge (3M™ ESPE™ Garant™ 2 system). The mixing ratio of the base paste to the catalyst paste is 10:1, and mixing is carried out automatically using a dispenser.

With the Garant 2 system, more material can be dispensed in the same time. The separate openings prevent cross-contamination of the base paste and the catalyst. A color coding system offers additional safety.

Constituents

The qualitative composition of Protemp 3 Garant is listed in Tables 2 and 3.

<table>
<thead>
<tr>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base paste</td>
</tr>
<tr>
<td>Dimetacrylate</td>
</tr>
<tr>
<td>Glass powder</td>
</tr>
<tr>
<td>Silicic acid</td>
</tr>
<tr>
<td>Initiators</td>
</tr>
<tr>
<td>Diacylate</td>
</tr>
<tr>
<td>Diacylate</td>
</tr>
<tr>
<td>Synthetic resins</td>
</tr>
<tr>
<td>Pigments</td>
</tr>
<tr>
<td>Dyes</td>
</tr>
</tbody>
</table>
**Test results**

**Material properties**

Besides sheer mechanical strength, the clinical success of a temporary restoration also greatly depends on physical parameters such as deflection at break, elongation at break and fracture resistance. All these indicators provide information about the resistance to fracture and the fracture rate of the material. A mastication simulator or the edge strength test provide important information on a material by simulating clinical conditions.

Examinations focusing on accuracy of fit, polishability and color stability offer further key data about the product.

Since the beginning of 2000, a wide range of scientific studies have been carried out to ascertain the performance offered by 3M™ ESPE™ Protemp™ 3 Garant™. In the subsequent sections, we will review the numerous material studies.

**Long-term strength**
M. Rosentritt, Dr. R. Lang, Dr. M. Behr, Prof. G. Handel, University of Regensburg

A mastication simulator was used to gain experience regarding long-term strength under thermocyclical and mechanical loads. In addition, the resistance to fracture of the materials was also tested.

In each case, the study used 10 three-unit bridges, which were fixed to molar preparations made of CoCr metal with periodontal positioning. Preparation involved the creation of a shoulder approx. 1 mm in size.

The test arrangement in the mastication simulator corresponds closely to the situation in the mouth and thus allows accurate forecasts to be made regarding performance under surgery conditions even at the stage of in-vitro testing.

![Fig. 9: Resistance to fracture after 24 hours and after mastication simulation + thermocycling](image-url)

<table>
<thead>
<tr>
<th>Material</th>
<th>Resistance to fracture after 24h (N)</th>
<th>Resistance to fracture after TCML (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protemp 3 Garant</td>
<td>1015</td>
<td>956</td>
</tr>
<tr>
<td>Protemp Garant</td>
<td>563</td>
<td>772</td>
</tr>
<tr>
<td>Luxatemp</td>
<td>513</td>
<td>759</td>
</tr>
<tr>
<td>Tempofit</td>
<td>540</td>
<td>*</td>
</tr>
<tr>
<td>Cronsin</td>
<td>567</td>
<td>*</td>
</tr>
<tr>
<td>Trim</td>
<td>484</td>
<td>*</td>
</tr>
</tbody>
</table>

* Fracture
3M™ ESPE™ Protemp™ 3 Garant™ showed the highest resistance to fracture and also the lowest fracture rate of all materials tested. The low-molecular acrylates used all fractured while subjected to the mechanical and thermal loads.

The mastication simulator provides initial indicators for the outstanding performance under surgery conditions and superiority of Protemp 3 Garant in comparison with its predecessor product, which proved its worth over many years. In addition, the force required to break a three-unit bridge surpasses the values of the competitor materials. Protemp 3 Garant is the only material with which just one out of the 10 bridges tested fractured under the mechanical load of more than 480,000 cycles. Furthermore, this fracture also happened after the largest number of masticatory cycles (n = 180164).
Edge strength
Prof. D. Watts, University of Manchester

Another aspect contributing to the resistance to fracture is edge strength. In a test arrangement developed by the University of Manchester, force was applied near the edge of the test specimen. This allows the clinically relevant marginal strength of a temporary restoration to be simulated. Thin margins are particularly at risk from chipping when an interim restoration is undergoing finishing or being worn in the patient’s mouth.

Force was applied at distances from 0.4 mm to 1.00 mm from the edge (in steps of 0.1 mm) after 1 month of storage under humid conditions at 37°C. The mean data are shown in Fig. 12.

![Edge strength graph](image)

<table>
<thead>
<tr>
<th>Material</th>
<th>Edge strength 0.4 mm from margin</th>
<th>Edge strength 1 mm from margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protemp 3 Garant</td>
<td>1930</td>
<td>2052</td>
</tr>
<tr>
<td>Temphase</td>
<td>734</td>
<td>485.3</td>
</tr>
<tr>
<td>Luxatemp</td>
<td>608.3</td>
<td>694.7</td>
</tr>
</tbody>
</table>

3M™ ESPE™ Protemp™ 3 Garant™ clearly stands out from the other composite materials tested. The edge strength of Protemp 3 Garant is three times higher than that of Temphase and Luxatemp.
Other mechanical strength properties
Prof. D. Welker, Dr. G. Rzanny, Dr. R. Göbel, University of Jena

Characteristic data which is easily accessible and routinely available, such as flexural strength and the elastic modulus, also provides basic information about the stability of a material. It is an indication of strength and resistance to deflection. High strength should not, however, be accompanied with brittleness, which can make the material susceptible to fracture. Pronounced elasticity combined with complete recovery after removal of the load is desirable to absorb peak forces without fracture or splintering of the restoration. Tensile strength and elongation at break may indicate the load and the tolerated level of deformation until fracture.

---

**Fig. 13:**
Flexural strength as measured in the 3-point bending test

**Fig. 14:**
Deflection as measured in the 3-point bending test as per DIN 53452; Trim > 5 mm deflection

---

<table>
<thead>
<tr>
<th>Material</th>
<th>Flexural strength, dry 24h</th>
<th>Flexural strength, saturated with water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protemp Garant</td>
<td>85</td>
<td>115</td>
</tr>
<tr>
<td>Protemp Garant</td>
<td>52,8</td>
<td>39,8</td>
</tr>
<tr>
<td>Luxatemp</td>
<td>57,2</td>
<td>91,5</td>
</tr>
<tr>
<td>Structur Dominant</td>
<td>81,1</td>
<td>92,2</td>
</tr>
<tr>
<td>Temphase</td>
<td>92</td>
<td>134</td>
</tr>
<tr>
<td>Trim</td>
<td>48</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Deflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protemp Garant</td>
<td>1,65</td>
</tr>
<tr>
<td>Protemp Garant</td>
<td>1,18</td>
</tr>
<tr>
<td>Luxatemp</td>
<td>1,07</td>
</tr>
<tr>
<td>Structur Dominant</td>
<td>0,92</td>
</tr>
<tr>
<td>Temphase</td>
<td>1,16</td>
</tr>
<tr>
<td>Trim</td>
<td>&gt;5</td>
</tr>
</tbody>
</table>
Flexural strength indicates under which load the test specimen breaks. Deflection shows which distance is tolerated before fracture occurs. As the objective is to avoid fracture where possible, high deflection seems desirable. However, high deflection represents trauma for the periodontium. Limited deflection combined with high flexural strength and a high elastic modulus, as observed for 3M™ ESPE™ Protemp™ 3 Garant™, offers the right balance for a high-quality interim restoration.

Information of a similar kind is also provided by the tensile test whose results are shown in the final graph, Fig. 16.
Precision fit
PD Dr. C.-P. Ernst, I. Harre, Prof. B. Willershausen, University of Mainz

One of the main functions of the temporary restoration is to protect the prepared tooth from thermal, mechanical and chemical influences. High marginal integrity is correspondingly important.

Evaluation of the marginal integrity for a range of temporary crown and bridge materials was the subject of a study performed by the University of Mainz. A new test was developed especially for this purpose.

A standard tooth was prepared for a crown and colored up to the preparation margin. Temporary crowns were created and applied to the tooth. Marginal inaccuracies were then quantified using digital image analysis of the exposed dentine surfaces (see Fig. 17 and Fig. 18).

![Fig. 17: Digital image analysis](image)

![Fig. 18: Quantitative image analysis of exposed dentine in pixels](image)

<table>
<thead>
<tr>
<th></th>
<th>Exposed dentine surface in pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protemp 3 Garant</td>
<td>19679</td>
</tr>
<tr>
<td>Protemp Garant</td>
<td>18614</td>
</tr>
<tr>
<td>Integrity</td>
<td>22943</td>
</tr>
<tr>
<td>Trim</td>
<td>23607</td>
</tr>
</tbody>
</table>

The marginal adaptation of 3M™ ESPE™ Protemp™ 3 Garant™ and its predecessor product Protemp Garant is significantly better than that offered by Integrity and Trim. No significant difference was observed between the two Protemp variants.
Abrasions
Prof. D. Welker, Dr. G. Rzanny, Dr. R. Göbel, University of Jena

For the success of the subsequent final prosthetic restoration it is essential for the prepared teeth to not only be protected from irritation but also to maintain or re-establish their position in relation to adjacent teeth and antagonists. The stability of occlusion can be evaluated by determining the wear resistance. Fig. 19 shows the results of the study performed at the University of Jena according to ACTA.

As regards wear resistance, the surface analysis of the abrasion profiles shows that the composite materials are greatly superior to the higher acrylates as well as to PMMA.

Biocompatibility

A high level of biocompatibility is an essential requirement for every dental material. Where temporary crown and bridge materials are concerned, the focus of attention must fall on the generation of heat during setting and monomer release.

Generation of heat
Prof. D. Welker, Dr. G. Rzanny, Dr. R. Göbel, University of Jena
Prof. D. Watts, Dr. S.-H. Kim, University of Manchester
Prof. H.-Ch. Lauer, Dr. P. Ottl, Dr. L. Hahn, University of Frankfurt

We basically distinguish between two measurement methods when determining the generation of heat during the setting of materials for temporary crowns and bridges: firstly, in-vitro measurement of the temperature in the pulp cavity of extracted teeth. Here the aim is to take the situation in the mouth into account by simulating it as closely as possible. Secondly, there is the alternative of measuring the temperature directly in the setting material. In this setting, the temperature peaks observed are naturally much greater, and the maximum temperature found varies with the volume of the test specimen. Although the
temperatures measured in the test specimens cannot be directly related to the clinical situation, they represent a simple method based on material characteristics suitable for the comparison of different products.

A study carried out at the University of Manchester measured the maximum temperature increase during the setting process in a bulk test specimen. As clearly shown by the following figure, the greatest increase in temperature was detected for the composite material Temphase.

Another study performed by the University of Jena came up with similar results (see Fig. 21). A 1 cm³ temperature-insulated sleeve was used to measure the maximum reaction temperature of various crown and bridge materials.
The two bisacrylate resins Temphase and Structur 2 SC and the acrylate Trim not only showed a fast setting reaction, but also maximum reaction temperatures which may be biologically unfavorable, depending on the clinical situation. Following comparative studies into heat generation in the pulp cavity and the resin itself, the critical temperature for the test design used here is 50°C.

With the help of a new, optimized initiator system it was possible to bring about a major improvement in 3M™ ESPE™ Protemp™ 3 Garant™ in comparison with Protemp Garant as regards the maximum generation of heat. This result has also been confirmed by the work group headed by Prof. Lauer, University of Frankfurt. In the cavity (bulk), the average maximum temperature developed by Protemp 3 Garant was 4.35°C less than for Protemp Garant. If a simulation test is carried out in the pulp cavity, an average maximum temperature reduction of 1°C is measured for Protemp 3 Garant.

**Monomer release**
3M ESPE internal studies

An internal study carried out by 3M ESPE into residual monomer detachment in temporary dental crown and bridge resins came to the conclusion that monofunctional acrylates show high residual monomer concentrations (MMA). Protemp 3 Garant also stands out favorably from standard composite materials in this regard. Monofunctional (meth)acrylates such as HEMA, for example, could not be detected with Protemp 3 Garant, either. This project will be presented at the annual congress of the DGZPW 2001 in Bad Homburg and published.

**Aesthetics**
Prof. Powers, Dr. D. Li, University of Houston
Dr. A. Fard, Dr. A.L. Neme, Dr. F.E. Pink, University of Detroit Mercy
3M ESPE internal studies

In the past, the functional aspects of interim restorations predominated, while today’s materials also have to cater to the increased demands placed on aesthetics. The patient expects a colorfast restoration while the dentist also attaches importance to the surface finish and good polishability.

At the University of Houston, color stability was examined using the xenon test after artificial aging with energy irradiation of 45kJ/m2. The figure included below clearly shows that it was the composite materials Protemp 3 Garant and Integrity which experienced the smallest changes in color. The monofunctional acrylate Trim and the MMA/PMMA material Jet showed much poorer results.
The positive effect on the surface finish produced by the new filler technology used for 3M™ ESPE™ Protemp™ 3 Garant™ is impressively demonstrated by two SEM pictures. On the left we can see the surface of Protemp Garant, and on the right that of Protemp 3 Garant. Anterior bridges were produced using both materials with the help of a silicone impression and left unpolished.

This situation is also clearly reflected in a study into polishing. This study compared two surface finishing techniques and evaluated them by means of profilometric scanning. The study performed at the University of Detroit Mercy showed the lowest surface roughness prior to polishing for Protemp 3 Garant and Luxatemp. In all cases, finishing with a diamond finishing bur resulted in smoother surfaces than with the use of discs, while the use of pumice tended to have an adverse effect.
Individualization
M. Rosentritt, Dr. M. Behr, Dr. R. Lang, Prof. G. Handel, University of Regensburg

Despite the uncontested disadvantages of MMA / PMMA materials and higher acrylates, they are still used at the dental practice due to the easier manipulation of colors and supplementation, repair of minor voids etc.. One of the objectives for the development of 3M™ ESPE™ Protemp™ 3 Garant™ was to allow for the individualization of color and form using a simple and high-quality technique. For this purpose, Protemp 3 Garant was ideally adapted to the veneering composite 3M™ ESPE™ Sinfony™. In particular, the aim was to ensure retention of Protemp 3 Garant’s tough-elastic characteristics even after supplementation. The dentist now has at his disposal a flowable, light-curable composite available in a wide range of colors. Another handling benefit is the fact that, both in the freshly made state and after aging (after wearing by the patient), the temporary restoration only has to be roughened. Additional bonding is not required.

If desired, supplementation or repair can also be carried out using other flowable composites according to the manufacturer's instructions. The use of Protemp 3 Garant as a self-curing supplementation composite is also possible.
The high performance offered by 3M™ ESPE™ Sinfony™ as an add-on material for 3M™ ESPE™ Protemp™ 3 Garant™ was backed up by data from a scientific study conducted at the University of Regensburg. Protemp 3 Garant test specimens offered identical levels of flexural strength before and after repair with Sinfony. Rival materials such as Luxatemp showed lower initial values. Although they exhibited higher flexural strengths after repair in some cases, they became concomitantly brittle due to the repair composite. This is shown – as already described in section 5.3 in detail – in a marked reduction in deflection values before fracture.

![Fig. 25: Flexural strength after immersion of test specimen in water (7 and 14 days) and roughening of test specimens using a bur](image)

<table>
<thead>
<tr>
<th>Material Combination</th>
<th>Flexural Strength [N/mm²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protemp 3 Garant/Sinfony</td>
<td>64</td>
</tr>
<tr>
<td>Luxatemp/Luxaflow</td>
<td>48</td>
</tr>
<tr>
<td>Temphase/Revolution</td>
<td>57</td>
</tr>
<tr>
<td>Zero value</td>
<td></td>
</tr>
<tr>
<td>Roughening with bur and repair</td>
<td>60 80 41</td>
</tr>
</tbody>
</table>

- [Bar chart showing flexural strength values for different materials](image)
3M ESPE internal application test

In an application test, 36 dentists carried out a total of 1,014 temporary restorations using 3M™ ESPE™ Protemp™ 3 Garant™. The observation period was 9 weeks. The dentists used a questionnaire to report their experiences with use and application of the product.

In terms of indications, crowns accounted for 56.7% of the restorations, bridges for 21.4%, inlays/onlays for 20.5% and veneers for 1.4% (see Fig. 26).

The working times were rated as good in all cases. The study asked about the key times for the work steps: application time, curing in the mouth/elastic phase and final curing/setting time (see Fig. 26).
The accuracy of the fit for the interim restorations produced was rated as flawless both on the preparation and as regards occlusal contacts (Fig. 28).

![Figure 28: Assessment of accuracy of fit](image)

A good overall rating was given for finishing. The individual results are shown in the following table.

<table>
<thead>
<tr>
<th></th>
<th>very good</th>
<th>good</th>
<th>satisfactory</th>
<th>improvement req.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of grinding</td>
<td>41.6</td>
<td>41.6</td>
<td>13.9</td>
<td>2.9</td>
</tr>
<tr>
<td>Finishing of fine margins</td>
<td>33.3</td>
<td>52.8</td>
<td>13.9</td>
<td>0</td>
</tr>
<tr>
<td>Polishability</td>
<td>33.3</td>
<td>55.6</td>
<td>11.1</td>
<td>0</td>
</tr>
<tr>
<td>Ease of finishing overall</td>
<td>30.6</td>
<td>58.3</td>
<td>11.1</td>
<td>0</td>
</tr>
</tbody>
</table>

The in-vitro studies described in the previous section indicated 3M™ ESPE™ Protemp™ 3 Garant™ to be a highly stable material with little risk of fracture. However, a material's true clinical qualities can ultimately only be proven by in vivo tests. This application test resulted in a fracture rate of only 1.3 %, corresponding to just 13 restorations. Their numbers by indication were as follows:

- Two partial crowns
- Three inlays
- Four five-unit, two four-unit and one three-unit bridge

74.3% of the dentists stated that they had not observed a single fracture.
Summary

3M™ ESPE™ Protemp™ 3 Garant™ is a temporary crown and bridge material used with the direct technique for

- crowns
- bridges
- inlays
- onlays

Protemp 3 Garant represents an innovative improvement of composite-based temporary crown and bridge materials.

Protemp 3 Garant is thus following the trend towards ever simpler yet higher-quality direct temporary restoration materials. When used in combination with the new 3M™ ESPE™ Garant™ 2 mixing system, handling also becomes less complicated and more reliable.

The new monomer system developed by 3M ESPE offers outstanding mechanical strength and high resistance to fracture without the brittleness associated with composites. High flexural strength combined with reversible deflection is achieved by means of a kind of “shock absorber”. This system cushions short-term peak forces without resulting in fracture or splintering of the restoration. The clinical consequence is an extremely stable interim restoration, including for bridges with wide spans.

Protemp 3 Garant is characterized by its excellent fit. The restorations produced do not require laborious reworking and offer the preparation, the gingiva and the periodontium ideal protection. The clinical result is assured by an exact marginal seal and stable occlusion as well as proximal support. The prerequisite for this is an elastic phase which has been optimized in terms of time and material characteristics and ensures reliable removal of the temporary restoration without permitting distortion, fractures or dimensional changes.

A further reduction in the generation of heat during setting provides Protemp 3 Garant with high biocompatibility. Unlike monofunctional acrylates, which show high residual monomer concentrations (MMA), no release of monofunctional (meth)acrylates such as HEMA could be detected for Protemp 3 Garant. In this regard, Protemp 3 Garant distinguishes itself from standard composite materials in a positive way.

The product offers a particularly smooth surface thanks to new filler technology and an optimized initiator system. The greatly reduced inhibition layer contributes to simple and fast polishing with reduced dust levels.

Protemp 3 Garant satisfies patient requirements for aesthetically appealing temporary restorations. The 3 colors A1 (extra-bright), A3 (bright) and B3 (yellow) based on the Vita system of shades provide for comprehensive treatment of all clinical cases.

If required, individualization or adjustments in shape are absolutely simple to perform. Supplementation of Protemp 3 Garant is possible without additional bonding using both Protemp 3 Garant and the flowable composite 3M™ ESPE™ Sinfony™—which has been in successful use for many years in dental laboratories. This can be done on the freshly-made or on the worn temporary restoration.
The new 3M™ ESPE™ Garant™ 2 system has further benefits to offer. For example, 3M™ ESPE™ Protemp™ 3 Garant™ can be dispensed much more easily from the 10:1 cartridge. In addition, more material can be applied to the temporary restoration key in less time. This is user-friendly and reliable. A uniform and reproducible setting time is the direct result for everyday applications at the dental surgery. This reliability aspect is backed up by separate openings for the basis and catalyst paste, which means that cross-contamination of the pastes is now ruled out.

Innovative developments for the initiator, matrix and filler as well as a new cartridge system make Protemp 3 Garant a next-generation temporary crown and bridge material. Clinical aspects and handling characteristics have been optimized likewise, ensuring that daily application at the dental surgery is easy and convenient.
Instructions for use

Information for use

Preparatory work
Take an alginate or silicone impression from the intact row of teeth.

• Instead of an impression, a laboratory-made vacuum-formed template or, for single crowns, a prefabricated crown can be used for shaping.
• To enhance the strength of the temporary restoration, remove interproximal grooves in the impression. If required due to tight spacing conditions, enlarge the relevant sites by cutting.
• Remove any undercuts to ensure that the impression can be easily reinserted in the mouth.
• If gaps are present (due to missing teeth or gaps between molars), cut a groove in the impression to ensure a stable, ridge-shaped connection in the temporary restoration.
• If required, prior to taking the impression close any gaps between front teeth using prefabricated teeth as space maintainers; use wax to stably interlock more than one prefabricated tooth.

Times
At a room temperature of 23°C (73°F) and a humidity of 50%, handling times are as follows:

<table>
<thead>
<tr>
<th>min:sec</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00</td>
<td>filling the impression and reinsertion</td>
</tr>
<tr>
<td>00:50</td>
<td>setting in mouth</td>
</tr>
<tr>
<td>01:35</td>
<td>removal from mouth</td>
</tr>
<tr>
<td>02:30</td>
<td>complete setting</td>
</tr>
<tr>
<td>05:00</td>
<td>finishing</td>
</tr>
</tbody>
</table>

Dosing and mixing
The appropriate quantities of the pastes are mixed statically in the 3M™ ESPE™ Garant™ 2 dispenser.
Allow refrigerated material to warm up to room temperature (23°C [73°F]) before use. Only use the enclosed blue Garant 2 mixing tips.

Functional check with new cartridges:
• Remove and discard the cartridge cap nozzle.
• Check whether both cartridge openings are free from obstruction and remove obstructing material, if any, with a suitable instrument.
• Extrude a small quantity of base paste and catalyst until both pastes emerge uniformly.

Application
It takes the material a certain amount of time to emerge from the newly attached mixing tip. Increasing the pressure does not accelerate the flow! The flow of material is interrupted as soon as the pressure on the handle is reduced. Material that has set inside the mixing tips should not be extruded by force, as this may damage both the cartridge and the mixing tip.
• First install a new mixing tip.
• Prior to each application, extrude a small (pea-sized) amount of paste from the mixing tip onto a mixing pad and discard this material.
• Subsequently, load the dried impression or vacuum-formed template in the relevant spaces from bottom up.
• Reposition the impression or vacuum-formed template in the mouth.
• The material attains a hard-elastic consistency approx. 1 min 35 sec after the onset of mixing. The material and the impression or vacuum-formed template must be removed from the mouth within approx. 2 min 30 sec after the onset of mixing.
• Check the setting progress by means of the excess material present in the mouth.
• Keep the filled mixing tip on the cartridge to serve as a cap until the next use.

Finishing
Do not inhale polishing dust: use suitable mouth protective device or aspiration.
• Finish the temporary restoration once the material is completely cured (not earlier than 5 minutes after the onset of mixing) using fine carbide burs. Polish if desired.
• The superficial inhibition layer formed at unpolished sites by the oxygen in air can be removed with organic solvents, e.g. alcohol.

Individualization / correction of the shape
Using 3M™ ESPE™ Sinfony™ and 3M™ ESPE™ Protemp™ 3 Garant™ for custom-shaping and correction of the shape there usually is no need for a bonding agent. If you intend to use other products, please refer to the pertinent manufacturer’s instructions for use.

Compatible products
The entire range of Sinfony products in all shades
• The following Sinfony shades match the Protemp 3 shades, e.g. for contact point corrections: Protemp 3 Garant A1: Sinfony D A1, Protemp 3 Garant A3: Sinfony T2, Protemp 3 Garant B3: Sinfony E6
• For details on the processing, please refer to the corresponding instructions for use of Sinfony.
Flowable composites
• Please comply with the corresponding instructions for use! Protemp 3 Garant
• Processing: please refer to the information provided under “Application” and “Finishing”.

Application of Sinfony to new temporary restorations
In newly manufactured temporary restorations, Sinfony can be applied either to the finished surface or the unprocessed, but clean, oxygen inhibition layer. Bonding is excellent in either case.
Any contamination – e.g. from saliva or polishing dust – should be removed with alcohol from temporary restorations with inhibition layers and finished temporary restorations, which should then be dried with a stream of air.
Alternatively:
If the inhibition layer or the finished restoration is clean, proceed as described in the next step.
• For hygienic reasons, dose Sinfony from the dispenser onto a mixing pad.
• Apply the composite to the temporary restoration in layers of max. 1 mm using a suitable instrument.
• Light-cure each layer separately for 5 sec each.
• Trim the Sinfony material with carbide burs and polish with polishing paste.
Application of flowable composites to new temporary restorations

- Remove the inhibition layer of the temporary restoration with alcohol.
- Thoroughly roughen the surface of the temporary restoration with rotary instruments.
- Remove any contamination – e.g. from saliva or polishing dust – with alcohol, then dry the restoration with a stream of air.
- Continue processing the composite in accordance with the corresponding instructions for use.

Application of 3M™ ESPE™ Sinfony™ to temporary restorations that were in use

- Thoroughly roughen the surface of the temporary restoration with rotary instruments.
- Remove any contamination – e.g. saliva or polishing dust – with alcohol, then dry the restoration with a stream of air.
- For hygienic reasons, dose Sinfony from the dispenser onto a mixing pad.
- Apply the composite to the temporary restoration in layers of max. 1 mm.
- Light-cure the individual layers for 5 sec each.
- Finish Sinfony with carbide burs and polish with polishing paste.

Application with flowable composites for temporary restorations that were in use

- Thoroughly roughen the surface of the temporary restoration with rotary instruments.
- Remove any contamination – e.g. from saliva or polishing dust – with alcohol, then dry the restoration with a stream of air.
- Continue processing the composite in accordance with the corresponding instructions for use of the composite.

Cementation
Eugenol-containing cements may impair the setting of composite luting cements to be used at a later time in the final luting step!

- Insert the temporary restoration with a commercial temporary cement, e.g. 3M™ ESPE™ Scutabond™ nf or 3M™ ESPE™ Procem™.

Repair

- If a restoration breaks shortly after manufacture re-assemble the fragments.
  Alternatively:
  Breakage of temporary restorations that have been worn: provide for mechanical retention by roughening the break surfaces and adjacent areas; produce undercuts, if required, and re-assemble the fragments in the proper orientation.
- Apply freshly mixed 3M™ ESPE™ Protemp™ 3 Garant™.
- Once the material is fully set, finish as usual.

Cleaning
Paste that has not yet set can be removed with organic solvents.

Incompatibilities
In susceptible individuals, sensitization to the product cannot be excluded. Use of the product should be discontinued and the product completely removed, if allergic reactions are observed.

Storage and shelf life
Do not store product above 25°C (77°F).
Do not use after product expiry date.
Step-by-step card

First use

Fig. 29: Step-by-step card for first use

Protemp™ Garant™ System – Step-by-step

Das 3M™ ESPE™ Garant™-System: Erstverwendung

The Garant system: First use
Making a temporary restoration

Protemp™ Garant™ – Step-by-step
Herstellung des Provisoriums mit Protemp 3 Garant
Making of a temporary restoration with Protemp 3 Garant
Fig. 30: Step-by-step card for making a temporary restoration using 3M™ ESPE™ Protemp™ 3 Garant™

Verarbeitungszeiten
Timetable

<table>
<thead>
<tr>
<th>Einbringen und Reponieren</th>
<th>Abbinding im Mund</th>
<th>Entnahme aus dem Mund</th>
<th>Vollständige Abbindung</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading and Insertion</td>
<td>Setting in the mouth</td>
<td>Withdrawing from the mouth</td>
<td>Complete Setting</td>
</tr>
</tbody>
</table>

0:50 0:45 0:55 2:30 5:00
Individualization and correction of shape using 3M™ ESPE™ Sinfony™

Fig. 31: Step-by-step card for individualization using the veneering resin Sinfony

Individualization and correction of the shape with Sinfony*

Vor Anwendung Gebrauchsinformation lesen. Consult instructions for use prior to use.

* Sinfony is not available in all countries

3M ESPE AG
D-82229 Seefeld · Germany

Telefon: +49 (81 52) 7 00-0
Telefax: +49 (81 52) 7 00-13 66
E-mail: info.3mespe@mmm.com
Internet: http://www.3mespe.de/
## Packaging

<table>
<thead>
<tr>
<th>Item number</th>
<th>Packaging</th>
<th>Content</th>
</tr>
</thead>
</table>
| 046 931     | PROTEMP 3 GARANT Starter Pack A3 | 1 PROTEMP 3 GARANT cartidge 50 ml (67 g)  
15 GARANT 2 mixing tips blue  
1 GARANT 2 dispenser complete 4:1/10:1 |
| 046 930     | PROTEMP 3 GARANT Starter Packung A3 with SINFONY | 1 PROTEMP 3 GARANT cartidge 50 ml (67 g)  
15 GARANT 2 mixing tips blue  
1 GARANT 2 dispenser complete 4:1/10:1  
1 SINFONY dispenser T2 |
| 046 951     | PROTEMP 3 GARANT Intro Pack A3 | 2 PROTEMP 3 GARANT cartidges 50 ml (67 g)  
30 GARANT 2 mixing tips blue  
1 GARANT 2 Dispenser complete 4:1/10:1 |
| 046 934 A1  | PROTEMP 3 GARANT Standard Pack in the shades A1, A3, B3 | 1 PROTEMP 3 GARANT Kartusche 50 ml (67 g)  
15 GARANT 2 mixing tips blue |
| 046 935 A3  | PROTEMP 3 GARANT Economy Pack in the shades A1, A3, B3 | 4 Standard Packs  
= 4 cartidges  
= 60 mixing tips |
| 046 936 B3  | PROTEMP 3 GARANT | |
| 071 453     | GARANT 2 mixing tips blue | 48 GARANT 2 mixing tips blue |
| 077 581     | GARANT 2 dispenser 4:1/10:1 | 1 GARANT 2 dispenser complete |
| 077 591     | GARANT 2 plunger 10:1 | GARANT 2 plunger 10:1 |
Bibliography

Literature on 3M™ ESPE™ Protemp™ 3 Garant™

C.-P. Ernst, I. Harre, B. Willershausen,
A new method to determine the marginal adaptation of temporary crowns, IADR meeting, Chiba, June 2001, accepted for publication.

A. Fard, A.L. Neme, F.E. Pink,

R. Hecht, U. Hoheisel, B. Windmüller,

S.-H. Kim, D.C. Watts,
Shrinkage and strength properties of temporary crown and bridge materials, BSDR meeting, Belfast, April 2001.

R. Lang, M. Rosentritt, M. Behr, G. Handel,

R. Lang, M. Rosentritt, M. Behr, G. Handel,

A. Preiss, N. Gunser, U. Hoheisel

D. Li, J.M. Powers,

M. Rosentritt, M. Behr, R. Lang, G. Handel,
In-vitro completion and repair of provisional crown and bridge materials, IADR meeting, Chiba, June 2001, accepted for publication.

D. Welker, A. Rzanny, R. Hecht, R. Göbel, M. Fachet, S. Nestler, U. Hoheisel, H. Küpper, M. Hinz, B. Windmüller,
General Literature

H. Albers,

Th. Berry, K. Troendle,
Provisional restorations; Guidelines for proper selection, placement,

F. J. T. Burke, R. J. Crisp,

G. J. Christensen,
Provisional restorations for fixed prosthodontics, JADA 1996, 127, 249-252.

Ch. Clauss, T. Kuretzky,

Ch. Clauss, T. Kuretzky,
Individuelle Provisorien, Teil II Dental Magazin 1996, 1.

Ch. Clauss, T. Kuretzky,

J.W. Farah,

M. Gongora, G. Bernal. C. A. Munoz, R. Feller,
Selected Physical Properties Of Five Provisional Resins For Fixed Restorations,

M. Gough,
A Review of Temporary Crowns and Bridges, Dental Update 1994, 6, 203-207.

B. Klaiber,
Provisorienkunststoff im Applikator – welche Vorteile eröffnen sich für die Anwendung?
Zahnarzt Magazin 1996, 1.

R. Lang, M. Rosentritt, A. Leibrock, M. Behr, G. Handel,
Color stability of provisional crown & bridge restoration materials,

R. Lang, M. Rosentritt, A. Leibrock, M. Behr, G. Handel,
Color stability of provisional crown and bridge restoration materials,

H.-Ch. Lauer,
Experimentelle Untersuchungen zur Wärmeentwicklung im Pulpakavum durch Kunststoff-

J.L. Lui, J. C. Setcos, R. W. Phillips,

R. Luthardt, M. Hinz, M. Stössel,
Vergleichende klinische Studie temporärer K&B-Kunststoffe,
R. Luthardt, M. Stößel, M. Hinz, R. Vollandt, E. Lenz,
Klinische Studie zur Qualität und Verarbeitung temporärer Kronen- und Brückenkunststoffe, 

R.G. Luthardt, M. Stößel, M. Hinz, R. Vollandt,
Clinical performance and periodontal outcome of temporary crowns and fixed partial dentures: 

M. B. Miller,

M. Nichols, G. Govin, C. Flaitz, K. Allen, J. Hicks,
Comparison of Provisional Posterior Coronal Restorations in a HIV-Dedicated Dental Clinic, 
IADR Meeting, Nice, 1998, Abstract # 2600.

M. Nichols, P. Balu, G. Govin, C. Flaitz, J. Hicks,
Provisional Posterior Coronal Restorations in a HIV-Dedicated Dental Clinic, 

P. Ottl, L. Hahn, H.-C. Lauer, C. Drews,
Intrapulpale Wärmeentwicklung bei der Polymerisation von Kunststoffprovisorien, 
Jahrestagung der DGZPW, Würzburg, 26.-29. 5. 1999, Poster #19.

R. Pannewig,
Provisorien-Herstellung – funktionell und effizient (1), 

R. Pannewig,
Provisorien-Herstellung – funktionell und effizient (1), 

L. Perinka, S. Bartuskova,
Provisional Posterior Bridge Restoration – Long Term Study, 

A. Rzanny, D. Welker, R. Göbel,
Werkstoffkundlicher Vergleich temporärer K&B-Kunststoffe, 

D. Welker, A. Rzanny, R. Göbel,
Interimsversorgungen bei Kronen- und Brückenersatz – Indikationen, Werkstoffe, 
biologische Aspekte, Methodik, Quintessenz Zahntech 1999, 25 (10), 1133-1144.

B. Windmüller,
Direkte provisorische Versorgung – ein kurzer Überblick, 

J. Wirz, N. Nigg, F. Schmidli,
Moderne Provisorienkunststoffe, Teil I: Materialübersicht und Untersuchungsmethoden, 

J. Wirz, N. Nigg, F. Schmidli,
Moderne Provisorienkunststoffe, Teil II: Resultate und Diskussion, 
Quintessenz 1995, 46, 245-255.