A collection of scientific results

Ketac Molar

Glass Ionomer Restorative Material
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Introduction

Dear Dental Professional,

Glass ionomers have been available to the profession for nearly a quarter of a century, and throughout this time 3M ESPE has continuously set new standards. Products such as Ketac™ Cem, Ketac™ Fil, Vitremer™ and Ketac™ Molar have each in turn broken new ground in the area of GIC development.

Atraumatic Restorative Treatment (ART) is a low risk economical procedure and can often save a tooth from extraction. By manually excavating the caries and filling the cavity with glass ionomer you can conserve tooth tissue and reduce the chance for further decay.

In 1997 3M ESPE launched Ketac Molar, a product that has proven its worth many thousand of times since then. Ketac Molar Easymix represents the latest contribution to the development of GIC. It has excellent compressive and flexural strength and thus is able to counteract occlusal loading, preventing restoration fracture.

With its new granulated formula, Ketac Molar Easymix is also easier for you to handle:

• The improved wettability means it mixes faster and more easily.

• You can measure this pourable powder more exactly, for accurate, reproducible mixing results.

• The granulated powder produces less dust, improving hygiene in your workplace.

Over time, Ketac Molar has attracted considerable scientific interest, and a wide range of studies have been published. In this brochure, you will find a review of the most important publications to date, along with answers to frequently asked questions about glass ionomer filling materials. Our goal is to keep you informed and help you to make up your own mind about Ketac Molar.

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Manager, Clinical Affairs
A number of reports on clinical evaluations have been published, particularly on use of Ketac Molar in the Atraumatic Restorative Treatment (ART) technique. Holmgren et al [1] reported three-year data on an ART clinical study in China. Two hundred sixty-seven ART Ketac Molar restorations in 197 children aged 12 to 13 years were evaluated, in particular for retention, secondary caries and anatomic form; 65% of these restorations had occlusal fissures sealed with Ketac Molar and these were also evaluated for retention and recurrent caries. The ‘press finger’ technique was used to place the restorations and sealants. The 3-year survival was 92% and 77% respectively for small and large Class I restorations, and 60% for Class II. The majority of failures were due to partial or complete loss of the restoration. The authors quoted Akerboom et al [2] in their comment that the failure rate for amalgam restorations in large Class I restorations might be expected to be higher than that seen in this study.

None of the 174 sealed teeth developed caries in the first year. Fissure caries was found in one tooth at 2 years where sealant was missing, and three teeth with missing sealant developed caries at 3 years. At 3 years, 72% of the sealants were partially or completely retained. The authors commented that the 3-year survival rate was high and that the sealant retention rate seen in this study was higher than that usually reported for glass ionomer sealants. This suggests that the viscous glass ionomer, Ketac Molar performs well with the ‘press finger’ technique for placement in the cavity and fissures.
Ketac™ Molar

Clinical Studies on Ketac Molar

Taifour et al [3] reported three-year results for ART Ketac Molar and Fuji IX (GC International Corp, Tokyo, Japan) restorations compared with conventional amalgams in primary teeth. At baseline 482 ART glass ionomer restorations and 353 minimal amalgam restorations were placed in 835 children aged 6 to 7 years. At three years, 80% of the restorations were available for recall. The cumulative survival of ART single surface glass ionomer restorations at three years was 86%, and of conventional amalgam 80%. The three year cumulative survival of ART multiple surface restorations was 49%, and for amalgam 43%. Secondary caries in single surface restorations was reported for 7% of ART and 14% of amalgams.

The authors concluded that the ART approach using glass ionomer gave better results than the traditional use of amalgam in minimal cavities.

Mickenautsch et al [4] placed 81 Ketac Molar and 82 Fuji IX restorations in one-surface cavities, including sealing the fissures, in permanent teeth in children of average age 10.5 years. The one-year survival rates were 94% for Ketac Molar and 93% for Fuji IX; retention of sealant was 76% and 81% respectively. Mickenautsch et al [5] in an earlier paper showed how adoption of the ART approach by their clinics had significantly reduced both the number of teeth being extracted and the use of amalgam. In the year prior to their adoption of ART, of the 3346 teeth treated 48% were extractions, 55% of restorations were conventional glass ionomer and 28% were restored with amalgam. After introducing the ART method, 8% fewer teeth were extracted, 98% of restorations were carried out using ART, and use of amalgam was virtually eliminated. They commented that the ART approach seemed to result in better patient acceptance of treatment. ART could be viewed as an acceptable alternative to amalgam restorations in children’s teeth.

| % survival rates for ART materials at 3 years [3] |
|---------------------|---------------------|---------------------|
|                     | Ketac Molar         | Fuji IX             | Amalgam             |
| Single surface restorations | 87%               | 85%                 | 80%                 |
| Multiple surface restorations | 48%               | 49%                 | 43%                 |

The authors concluded that the ART approach using glass ionomer gave better results than the traditional use of amalgam in minimal cavities.
Remineralizing effects of Ketac Molar

Ketac Molar has been shown to inhibit demineralization of enamel in artificial caries studies [6]. Polarized light microscopy was used to measure the width of inhibition zones created by various materials against acid attack on enamel. Ketac Molar gave demineralization-free zones of 25% compared with Fuji IX with 21%.

The authors reported that the artificial demineralizing solution used, which had a pH of 4.7, caused a significant erosive surface loss of 51 microns for Fuji IX compared with 9 microns for Ketac Molar.

Jang et al [7] evaluated the ability of glass ionomer materials to remineralize adjacent interproximal incipient caries lesions in vitro. Ketac Molar resulted in a 20% (sd=17) reduction in lesion area compared with Fuji IX at 15% (sd=8).

Caries protective effects of Ketac Molar

Microhardness measurements were used to test the protective effect of Ketac Molar and other glass ionomer restoratives placed in cavities in sound bovine enamel [8]. The sterilized tooth slabs with the test restorations were inserted into dentures worn by volunteers and were exposed to cariogenic conditions for 70 days. Compared to the resin composite control, Ketac Molar had a 69% caries protective effect, a statistically significant result.
Boeckh et al [9] reported on the antibacterial effect of Ketac Molar and other materials against Streptococcus mutans. The strongest antibacterial action was seen with zinc oxide/eugenol (ZOE), the control material. Ketac Molar also produced significant inhibition of bacterial growth. The authors carried out a second test consisting of an eluate assay which was considered to more closely reflect the clinical situation. In the assay test only Ketac Molar and ZOE were able to inhibit bacterial growth, the other materials being tested allowing bacteria to proliferate.

![Graph showing growth inhibition](image-url)
Other researchers have evaluated surface hardness of materials at various time frames and under different storage conditions. Peutzfeldt et al [10] measured Rockwell hardness and three-body wear (200,000 cycles) for a number of materials. Ketac Molar and Z100 demonstrated the lowest amounts of wear in this study.

### Hardness and wear measurements [10]

<table>
<thead>
<tr>
<th>Material</th>
<th>Hardness</th>
<th>3-Body wear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ketac Molar</td>
<td>38.2 (2.8)</td>
<td>37 (5)</td>
</tr>
<tr>
<td>Fuji IX</td>
<td>35.5 (1.5)</td>
<td>49 (6)</td>
</tr>
<tr>
<td>Fuji II LC</td>
<td>27.7 (1.6)</td>
<td>117 (21)</td>
</tr>
<tr>
<td>Dyract</td>
<td>38.9 (1.5)</td>
<td>76 (2)</td>
</tr>
<tr>
<td>Z100</td>
<td>62.6 (1.8)</td>
<td>15 (3)</td>
</tr>
</tbody>
</table>

### Strength testing

Compressive, diametral tensile and flexural strength measurements have been reported for Ketac Molar in comparison with various other materials. Ketac Molar consistently showed an increase in strength over time [11,12,13]. The high powder to liquid ratio in Ketac Molar gives it high compressive strength [14]. The compressive strength obtained when the material is hand mixed, compared with mixing in a Capmix, is reduced by only 2% [15], the Rotomix tending to produce a stronger material. The authors commented that the high concentration of glass filler is responsible for the superior physical properties of Ketac Molar.

In a study testing the strength of glass ionomers subjected to heat or ultrasonic application during the setting reaction, the materials showed increased compressive strength [16].

### Compressive strength at 1 hour (sd) [15]

<table>
<thead>
<tr>
<th></th>
<th>Ketac Molar</th>
<th>Fuji IX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard cure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23°C</td>
<td>86 (11) MPa</td>
<td>83 (6) MPa</td>
</tr>
<tr>
<td>Ultrasonic</td>
<td>118 (21) MPa</td>
<td>90 (15) MPa</td>
</tr>
<tr>
<td>Heat 70°C</td>
<td>145 (12) MPa</td>
<td>117 (15) MPa</td>
</tr>
</tbody>
</table>
Lim et al [17] measured color stability for a number of glass ionomers stored in various solutions for up to 56 days. Ketac Molar showed no effect on storage in 75% ethanol, and some color change on storage in 10% hydrogen peroxide. Fuji IX was particularly damaged by hydrogen peroxide storage resulting in a large color change and extensive surface cracking.
The clinical studies in particular provide evidence of the effectiveness of Ketac Molar as a restorative. For the ART procedures good three-year data are reported in two separate studies [1,3], a further study reporting one-year results [4]. It is of value that Ketac Molar, a viscous glass ionomer, has been shown to perform well both as a restorative and a sealant when placed using the ‘press finger technique’ [1].

The high powder to liquid ratio in Ketac Molar gives it excellent strength yet allows fluoride release and recharge to take place [10], enabling remineralization of the adjacent tooth substrate [6,7].

The studies reviewed here are an endorsement of Ketac Molar in its intended clinical use.


