G-ænial® Universal Injectable from GC

TECHNICAL MANUAL

Version 1.0 – October 2018

Table of Contents

1. Introduction to G-ænial Universal Injectable

A low viscosity composite usually displays an increased wettability and an enhanced adaptation to the cavity walls. It adapts naturally to the tooth structure, meaning that less instrument manipulation is necessary to restore the cavity. The first generations of low-viscosity composites were mainly comprised of resin, with low filler rates. Hence, they could only be used as fissure sealants, liners or for small restorations[1]. In order for a composite to have wider indications, a higher filler rate is necessary to provide sufficient strength and wear resistance.
In practice, from a manufacturing point of view, **embedding a high amount of fillers into a composite is quite challenging** and is limited by a number of factors. Nanofillers have a tendency to aggregate tightly, creating micron-sized filler-clusters – while a homogeneous and uniform dispersion of fillers is crucial to achieve the highest physical properties. **Another extremely important factor is to efficiently coat the particles with a silane coupling agent.** Coating influences the durability of the link between the fillers and the matrix, as well as the surface energy of the particles. Various techniques have been used to optimise the coating level and dispersion of particles, but there is no one single recipe to guarantee success.

GC R&D has focused on these two important parameters (uniform filler dispersion & efficient filler silanisation) and developed proprietary technologies that enabled to improve the strength of GC composites while maintaining their low viscosity. In 2010 GC launched G-ænial Universal Flo, the first injectable composite eligible for the complete restoration of all cavities. Since then, GC R&D continued to develop these technologies in order to further improve the product, with a focus on enhancing the handling and the mechanical properties. **The result of these improvements is G-ænial Universal Injectable, GC's latest injectable composite.**

This technical manual provides information on the innovative formulation and properties of G-ænial Universal Injectable – a unique product whose strength and wear resistance are as high as conventional posterior composites, while offering very easy handling and effortless adaptation.

2. Product description

G-ænial Universal injectable is a light-cured, radiopaque universal high-strength composite that can be used for **all restorative indications** while offering **excellent viscosity and perfect direct syringe application**. It has enhanced **thixotropic properties** that allow you to create the most beautiful & durable restorations with a minimum of manipulation.

Full Silane Coating Technology

Despite its injectable viscosity, G-ænial Universal Injectable has a **high filler rate of 69 wt.%** (Figure 1). Its formulation is based on **ultra-fine barium particles (150nm)**, which are strongly bonded into the resin matrix thanks to GC's **Full-coverage Silane Coating** (FSC) technology (Figure 2). To optimally coat the particles, the chemistry of the coating and the filler surface, along with the interaction between them play an important role. The FSC technology is GC's latest innovation to ensure an optimal filler silanisation.

Thanks to this technology:

- The surface of the fillers is **almost fully coated** by the silane coupling agent
  - Even better than in G-ænial Universal Flo (GUF), which already had a very good silanisation of the fillers
- The **wettability** of the fillers and **linkage** to monomers are improved
- The fillers are **dispersed** in a very efficient way
- The **extrusion pressure** and **stickiness** of the material are reduced
- An **excellent thixotropy** is achieved: perfect adaptation combined with high resistance to slumping (Figure 3) in a non-sticky formula

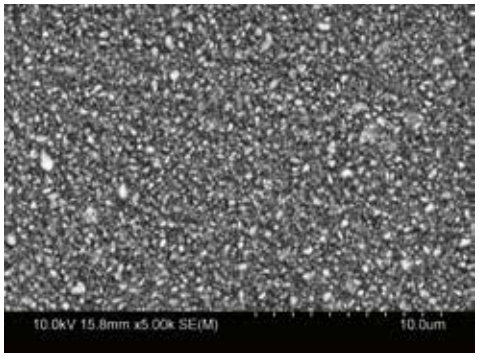


Figure 1: SEM image of G-ænial Universal Injectable showing ultra-fine and uniformly dispersed Barium fillers

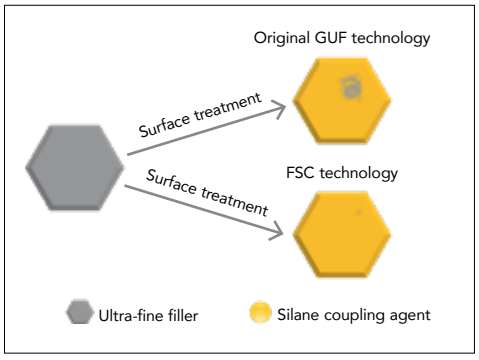


Figure 2: The FSC technology used in G-ænial Universal Injectable enables an optimal silanisation of the fillers

Figure 3: The thixotropy of G-ænial Universal Injectable allows a good adaptation and wettability, while still maintaining its shape without slumping

3. Indications

- **Direct restorative for Class I, II, III, IV and V cavities**
- Fissure sealant
- Sealing hypersensitive areas
- Repair of (in)direct aesthetic restorations, temporary crown & bridge, defect margins when margins are in enamel
- Blocking out undercuts
- Liner or base
- Realisation of crowns & bridges, inlays and veneers using the indirect technique in combination with GRADIA or GRADIA PLUS components
- Splinting of teeth in combination with fibres such as GC everStick fibres

Figure 4: G-ænial Universal Injectable can be used for all cavity classes, without size limitations.

4. Features and benefits

- **Exceptional strength & wear resistance** thanks to the ultra-fine barium fillers and GC's Full-coverage Silane Coating (FSC) technology
- Suitable for **any cavity class without size limitation**
- Strong enough **without the need to cover** with a conventional composite
- Unique **thixotropic viscosity**, optimal for **free-hand build-up of cusps**
- **Shorter finishing steps** as the anatomy is already created during placement
- New syringe design: **easy extrusion** & **no uncontrolled flow-out**
- **Reduced stickiness** to easily separate the material from the tip
- New tips with a **long bendable nozzle** for extremely **easy access** to difficult posterior cavities
- Excellent **polishability** and **gloss retention**
- **Wide range of shades** in three levels of translucency

5. Composition

G-ænial Universal Injectable		Content (% in weight)
Matrix	Methacrylate monomer	31%
Fillers	Silica	69%
	Barium glass	
Pigments		Trace
Photo initiator		Trace

Table 1: Open formula of G-ænial Universal Injectable

6. Scientific research on G-ænial Universal Injectable

6.1 Flexural strength

Flexural strength is defined as a material's ability to resist deformation under load. In clinical situations, dental restorations need to withstand repeated masticatory forces. A high flexural strength is desired to maintain the shape when these forces impact the restorations[2].

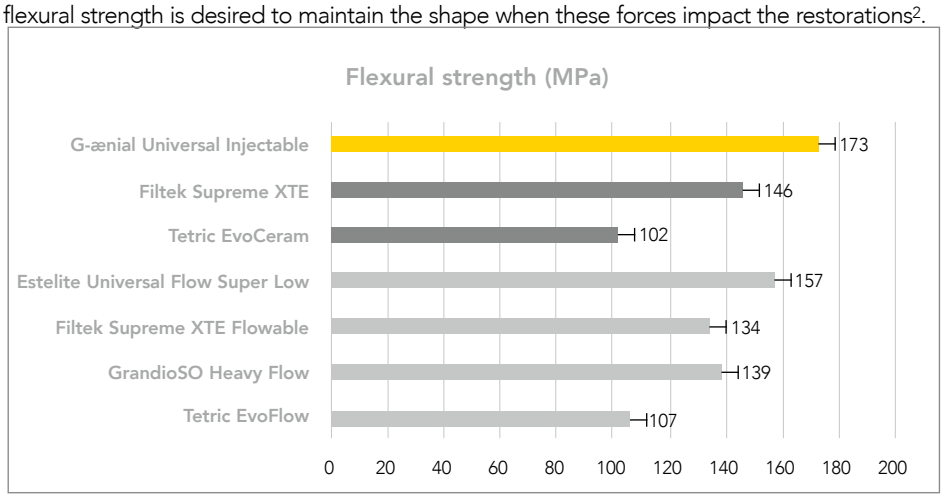


Figure 4: Flexural strength of various conventional paste-like and flowable composites in comparison to G-ænial Universal Injectable. Flexural strength was measured following the ISO 4049:2009 specifications.
Source: GC Corporation, R&D department, Japan, 2018. Data on file.

Within the limitations of this test, it can be concluded that **the flexural strength of G-ænial Universal Injectable is similar or superior to the paste-type composites tested** due to optimised monomer composition and the new surface treatment technology[3]. The high filler rate (69 wt.%) also plays a substantial role in this achievement.

6.2 Elastic Modulus

The modulus of elasticity (Young's modulus) is a measure of the rigidity of the material and is defined by the initial slope of the stress-strain curve.
A high modulus of elasticity means that the material is rigid and stiff. A material with a low modulus of elasticity is more flexible and is better able to buffer the masticatory pressure.

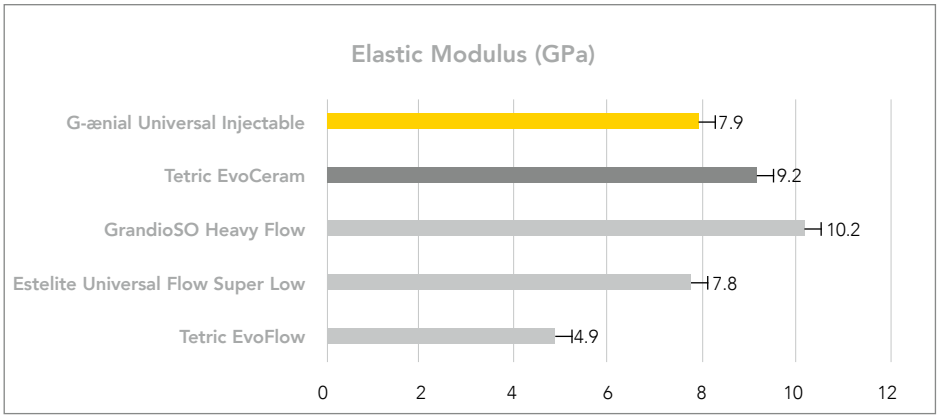
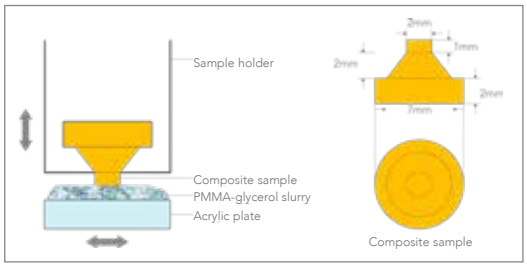


Figure 5: Elastic modulus of various conventional paste-like and flowable composites in comparison with G-ænial Universal Injectable. Elastic modulus was measured following the ISO 4049:2009 specifications.
Source: GC Corporation, R&D department, Japan, 2018. Data on file.

Within the limitations of this test, it can be concluded that **G-ænial Universal Injectable has a balanced elastic modulus**, in between those of conventional paste-like and flowable composites.

6.3 Three-body wear

Wear is the loss of material resulting from the contact between two or more materials. The three-body wear test is used to obtain a close reproduction of the wear in the oral cavity, including contact with opposing dentition, and the presence of a bolus.



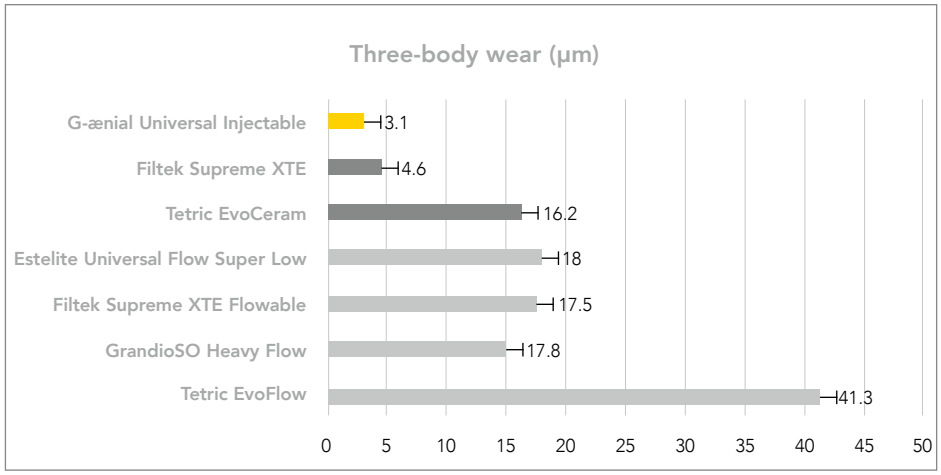


Figure 6: Three-body wear of various conventional paste-like and flowable composites in comparison with G-ænial Universal Injectable. In the test, specimens were loaded with 0,84 MPa (300g) for 100.000 cycles, using a slurry of PMMA and glycerol at a 1:1 ratio.
Source: GC Corporation, R&D department, Japan, 2018. Data on file.

G-ænial Universal Injectable is highly wear-resistant, which is especially beneficial in the treatment of occlusal wear. This high wear resistance can be attributed to the ultra-fine fillers (150nm) that are extremely well bonded to the matrix thanks to GC's FSC technology.

6.4 Gloss retention

Gloss retention is the material's resistance towards abrasive action, such as toothbrushing. It depends on the structure and surface hardness of the components. Gloss retention is important for long-term aesthetics, but also to avoid plaque retention.

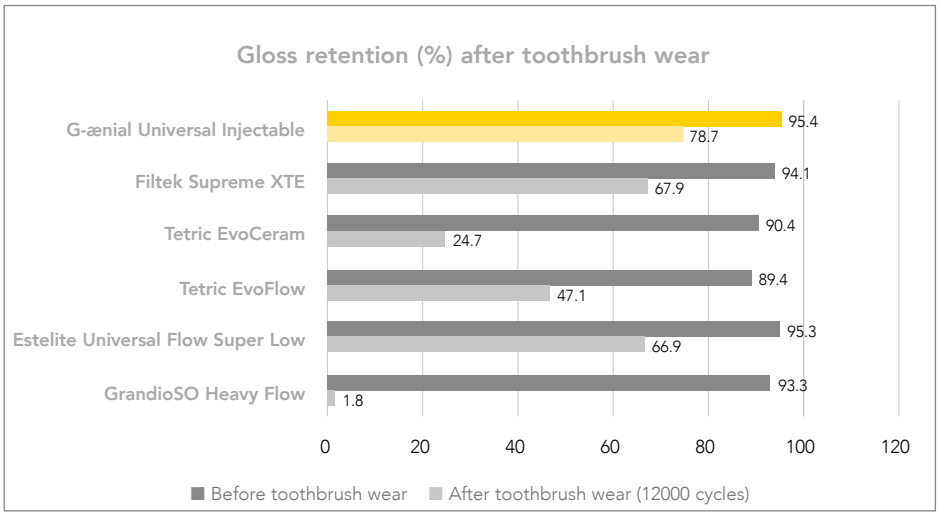


Figure 7: Gloss retention of various conventional paste-like and flowable composites in comparison with G-ænial Universal Injectable before & after 12000 cycles of toothbrush wear at a load of 200g with a toothbrush, toothpaste and water slurry (1:2 mixture ratio). Gloss can be observed with the naked eye at levels above 40%.
Source: GC Corporation, R&D department, Japan, 2018. Data on file.

G-ænial Universal Injectable maintains its gloss over time better than other paste-like and flowable composites. This high gloss retention is also linked to the use of ultra-fine fillers and to the FSC technology.

6.5 Radiopacity

For restorative materials, **a high radiopacity is required so the restorations cannot be misinterpreted as caries or tooth substrate on a radiographic image**. Specimens are compared with aluminium of the same thickness.

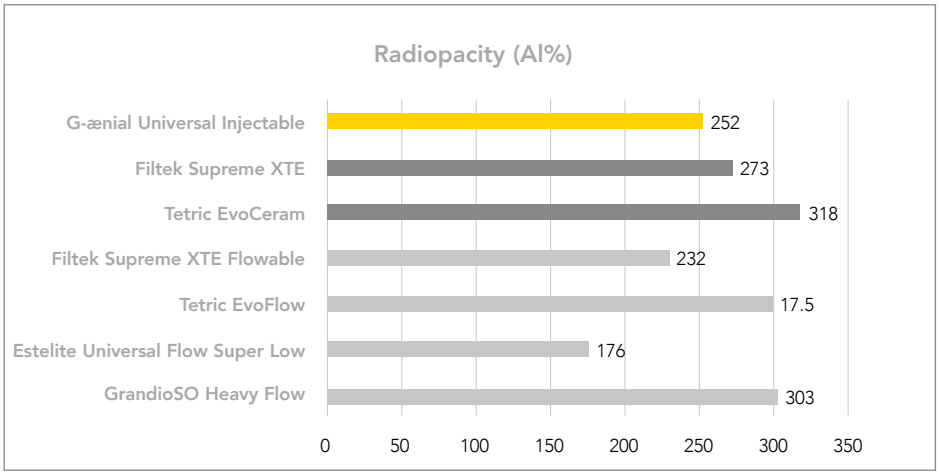


Figure 8: Radiopacity (as compared to aluminium) of various conventional paste-like and flowable composites in comparison with G-ænial Universal Injectable
Source: GC Corporation, R&D department, Japan, 2018. Data on file.

G-ænial Universal Injectable exhibits an optimised radiopacity that is sufficient to easily distinguish it from caries and tooth tissue, but not too high not to cause any artifacts. This level of radiopacity is achieved thanks to the use of barium fillers.

6.6 Water sorption

Water sorption affects the dimensional stability of a restorative material. Hydrolytic degradation of the polymer matrix and of the coupling between matrix and filler also reduces the mechanical properties. Therefore, low water sorption is desirable[2].

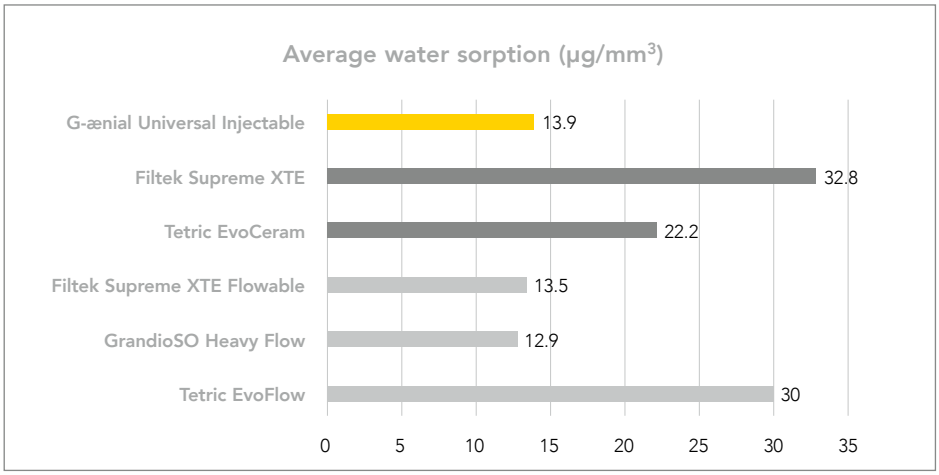


Figure 8: Average water sorption of various conventional paste-like and flowable composites in comparison with G-ænial Universal Injectable. Water sorption was measured following the ISO 4049 specifications.
Source: GC Corporation, R&D department, Japan, 2018. Data on file.

G-ænial Universal Injectable exhibits low water sorption, thanks to the use of a new long alkyl chain silane coupling agent which makes the filler surface more hydrophobic. The low water sorption is beneficial for the durability and long-term performance of the material.

6.7 Discolouration

A composite that tends to discolour will lose its beauty over time. The tendency to discolour is also related to water sorption, since pigments in solutions can be absorbed in the process as well.

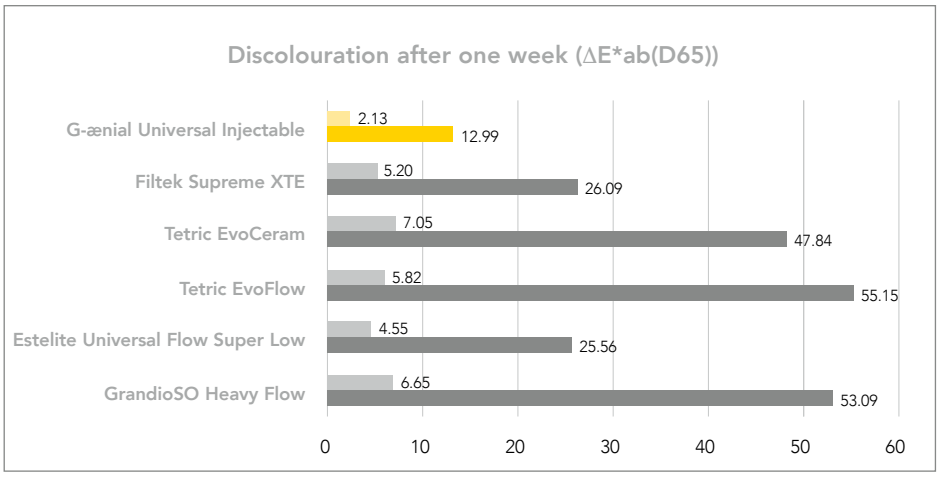


Figure 9: Colour change in average daylight of various conventional paste-like and flowable composites in comparison to G-ænial Universal Injectable after one week immersion in either 2% coffee or 2% curry solution. D65 is the standard daylight illuminant.
Source: GC Corporation, R&D department, Japan, 2018. Data on file.

The low water sorption of G-ænial Universal Injectable is also reflected in its excellent resistance to discolouration, as demonstrated with immersion in coffee and curry solutions.

6.8 Shrinkage

Shrinkage is inherent to all dental composites. Due to the confinement inside the cavity, shrinkage may manifest itself as shrinkage stress. **Shrinkage stress is a rather complex phenomenon and it is not linearly related to volumetric shrinkage**. Rather, it is dependent on many factors, such as material's properties (elastic modulus, water sorption and shrinkage kinetics) as well as clinical circumstances (cavity size and configuration) and thus may differ per indication. In fact, there is no proven correlation between the volumetric shrinkage of dental composite restorations and their clinical outcome[4].

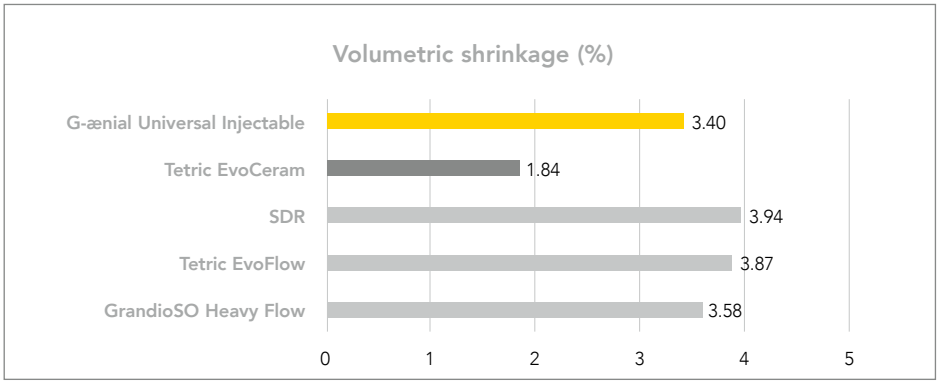


Figure 10: Volumetric shrinkage of a conventional paste-like composite, a bulk-fill composite and various flowable composites in comparison to G-ænial Universal Injectable.
Source: GC Corporation, R&D department, Japan, 2018. Data on file.

G-ænial Universal Injectable has a volumetric shrinkage comparable to bulk-fill and conventional flowable composites, but higher than conventional paste-like composites. Considering that the material is placed in increments and shows excellent visco-elastic behaviour in a rather long pre-gelation phase, **its volumetric shrinkage does not necessarily lead to a high shrinkage stress in a clinical set-up.**

6.9 Extrusion pressure

Extrusion pressure is directly related to the handling of a material. Ideally, the material does not flow out of the syringe spontaneously, but it can be extruded with low pressure. The lower the pressure needed, the easier it is to apply it with optimal comfort.

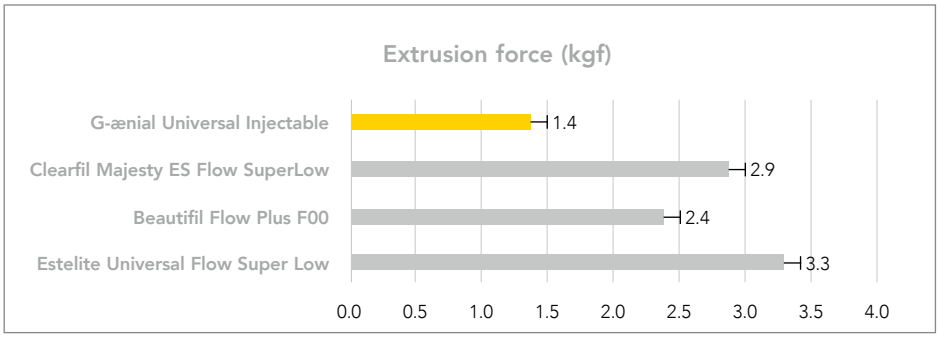


Figure 11: Extrusion pressure of various flowable composites in comparison to G-ænial Universal Injectable.
Source: GC Corporation, R&D department, Japan, 2018. Data on file.

G-ænial Universal Injectable can be extruded with lower force than competitor flowable composites. Together with its balanced viscosity and thixotropy, it is optimised for maximum control during placement and to ensure a comfortable application.

7. Restorative Techniques

Thanks to its **very high strength and wear resistance**, G-ænial Universal Injectable has **wide indications** and is **optimal for a variety of restorative techniques**. Its unique thixotropic properties allow **easy anatomical build-up** and open new restorative options.
G-ænial Universal Injectable's **excellent shaping ability and polishability** further ease the procedure by **shortening the finishing & polishing steps**.

A large range of **16 shades in three translucency levels** offers unlimited aesthetic possibilities.

Here, a few restorative techniques are highlighted where G-ænial Universal Injectable's unique features enable both a time-efficient procedure & excellent results.

7.1 Full Class II restoration

Dr. Javier Tapia Guadix, Spain

A classic Class II cavity can also be filled with an injectable technique. This is particularly interesting when dealing with narrow spaces and undercuts.

Initial situation. There is no contact between the first and second premolars.

Presence of caries in the distal box.

After removal of caries and of the old restoration.

Placement of the sectional matrix (Polydentia).

After adhesive application (G-Premio BOND), the undercuts are filled with G-ænial Universal Injectable (shade A4). The access to undercuts is made easy by the bendable tips.

Building up the distal approximal wall with the JE shade. No instruments are necessary, the material stays in place and requires minimal manipulation.

After building up the distal wall, the matrix can be removed and the cavity can be filled as a Class I (shade A4).

Filling the occlusal part of the cavity (shade JE).

A tight contact point and a nice aesthetic result are obtained.

7.2 Full Class II restoration, cusp by cusp

Dr. Javier Tapia Guadix, Spain

G-ænial Universal Injectable does not slump, so it's really easy to create the morphology by placing it cusp by cusp. Sculpting instruments are not needed; only minimal manipulation with a probe is required.

Selective etching of the enamel.

Bonding with G-Premio BOND.

Creating the proximal wall (shade JE).

Placement of the base layer (shade A4).

Creating the DV cusp (shade JE).

Creating the palatal cusp.

The composite can be shaped easily, just with a fine probe.

Shaping the DP cusp.

Shaping the MV cusp.

Accentuating the fissures with a probe.

Finishing and polishing.

Final result.

7.3 Injection moulding technique

Dr. Ali Salehi, France

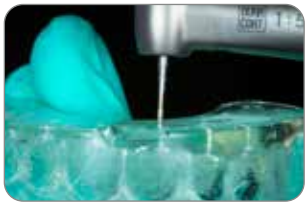
The injection moulding technique is particularly interesting when morphology is detailed and complex; you copy the diagnostic wax-up easily with a clear silicone and use it as a mould. Chair-time can be considerably reduced this way.

Initial situation.

Model with wax-up of the desired teeth shape.

An impression tray is filled with EXACLEAR (GC).

The desired shape is copied. The mould can be easily separated from the impression tray and the model.



Holes are drilled in the EXACLEAR mould through which the composite will be injected.

Etching the enamel.

Application of the adhesive (G-Premio BOND).

Injection of the composite (shade A1) into the mould. This process is repeated for each tooth.

Finishing the approximal margins.

Polishing the composite restorations.

Result after polishing.

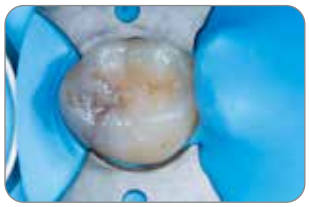
Smile after treatment.

7.4 Stamp technique

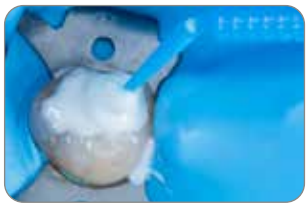
Dr. Ali Salehi, France

With the stamp technique, the original morphology of the occlusal surface can be exactly reproduced. It requires some more time in the restoration phase, but the time needed for finishing and polishing is reduced.

Initial situation: caries are visible but the anatomy is intact.

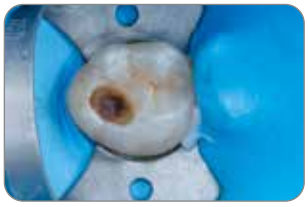


After placement of the rubber dam.

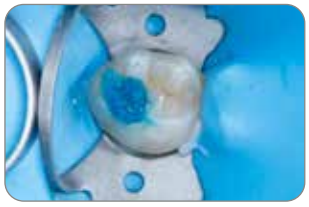


The stamp is created by taking an impression of the surface with a flowable composite.

Close-up of the stamp.

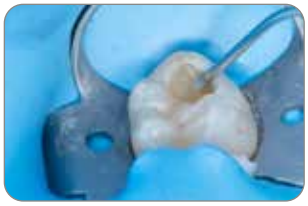


After cavity preparation.

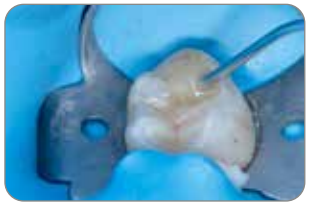


Etching of the enamel with phosphoric acid.

Application of the adhesive.



Injecting G-ænial Universal Injectable into the cavity (shade A3)



Slighty overfilling the cavity (shade A2).

Pressing the stamp onto the uncured filling.

The stamp is isolated from the composite with Teflon tape. Curing can occur through the tape.

Result after polishing. The natural anatomy is maintained.

8. Packaging and ordering information

Article code WEP	Article code EEP	Description
901471	901487	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), XBW
901472	901488	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), BW
901473	901489	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), A1
901474	901490	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), A2
901475	901491	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), A3
901476	901492	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), A3.5
901477	901493	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), A4
901478	901494	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), B1
901479	901495	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), B2
901480	901496	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), CV
901481	901497	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), CVD
901482	901498	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), AO1
901483	901499	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), AO2
901484	901500	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), AO3
901485	901501	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), JE
901486	901502	GC G-ænial Universal Injectable, Syringe 1x1mL (1,7g), AE
901503		GC Dispensing Tip Long Needle (30 pc.)

8. References

1. Shaalan O, Abou-Auf E, El Zoghby A. Clinical evaluation of flowable resin composite versus conventional resin composite in carious and noncarious lesions: Systematic review and meta-analysis. J Conserv Dent. 2017;20(6):380-385.

2. Heintze SD, Zimmerli B. Relevance of in vitro tests of adhesive and composite dental materials, a review in 3 parts. Part 1: Approval requirements and standardized testing of composite materials according to ISO specifications. Schweiz Monatsschr Zahnmed. 2011;121(9):804-816. doi:smfz-2011-09-01 [pii]

3. Miyagawa A, Murata T, Kimura T, Ueno T, Kumagai T. Mechanical Properties of Novel Injectable Composite Resin, G-ænial Universal Injectable. J Dent Res. 2018;97(Special Issue B):#2000.

4. De Castro Kruly P, Giannini M, Pascotto RC, et al. Meta-analysis of the clinical behavior of posterior direct resin restorations: Low polymerization shrinkage resin in comparison to methacrylate composite resin. PLoS One. 2018;13(2):1-18. doi:10.1371/journal.pone.0191942

Notes

Notes

Notes

GC CORPORATION
76-1, Hasumuma
Choltabashi-ku
JP-Tokyo 174-8585
Tel. +81.339.65.1221
Fax. +81.339.65.3331
http://www.gcdental.co.jp

GC EUROPE N.V.
Head Office
Researchpark
Haasrode-Leuven 1240
Interleuvenlaan 33
B-3001 Leuven
Tel. +32.16.74.10.00
Fax. +32.16.40.48.32
info.gce@gc.dental
http://www.gceurope.com

z O MA EN 8 83 10/18