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MECHANICAL CHARACTERIZATION OF STYLAGE® DERMAL FILLERS VERSUS CLINICAL PERFORMANCES AND INJECTION PLANS

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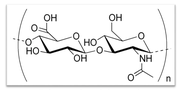
INTRODUCTION

Hyaluronic acid



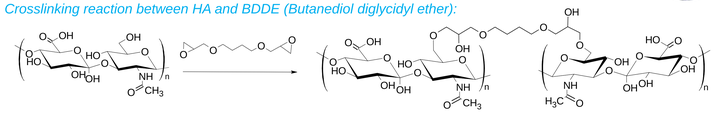
Disaccharide unit

- Composed of **D-glucuronic acid** + **N-acetyl-D-glucosamine** units, linked via β-glycoside bonds
- **Natural** polysaccharide, widely used in the **biomedical field**
- **Features** : Biocompatibility, biodegradability and biological properties
- **In aesthetic medicine** :
  → Used as dermal filler available in prefilled syringes.
  → Injected into the skin tissue in order to smooth and/or lift the skin

- **Chemical modification to obtain an hydrogel**

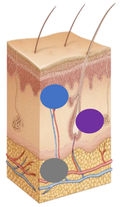
Crosslinking reaction = Creation of covalent bonds between the polymer chains
→ Formation of a **3D network** with **improved mechanical properties** and **longer persistence** under the skin

Crosslinking reaction between HA and BDDE (Butanediol diglycidyl ether):



IPN-like technology : Vivacy's patented crosslinking method, consisting in two interpenetrated networks
Stylage® range of crosslinked HA: Hydromax, S, M, L, XL and XXL

DERMAL FILLING ECOSYSTEM



Products class	Need	Injection plans	Tissue features	Key properties
Mesotherapy	Skin Hydration & Rejuvenation	Epidermis Dermo-epidermic junction Papillar dermis	Stiff but thin tissue	Adaptability to the tissue
Fillers	Wrinkle & Skin depression filling	Papillar & Reticular dermis	Dense tissue	Scalable properties in function of the injection depth
Volumizers	Volume restoration	Hypodermis & Subcutaneous tissue	Loose tissue	Strong mechanical properties to support the tissue

AIM

In order to achieve their clinical performances, dermal filling products have to fulfil three main functions: Injectability, persistence on site and mechanical support.

The objective of this study is thus to investigate the injectability and viscoelastic properties of the Stylage® range of products and emphasize their relevance with regard to their targeted clinical effect.

METHOD

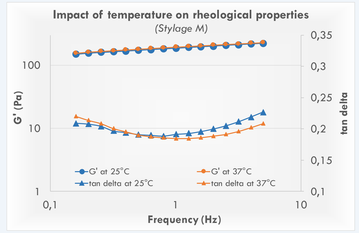
Rheological measurements were carried out using a DHR-2 controlled stress rheometer (TA instruments) with a cone-plate geometry.

- ***Elastic modulus*** (G') and ***loss factor*** (tan δ) → frequency sweep 0.1 to 5 Hz & Strain 0.8%
- ***Yield stress*** (τ_c): stress value at the moduli cross-over point → strain sweep from 0.1 to 1000% strain at 1 Hz

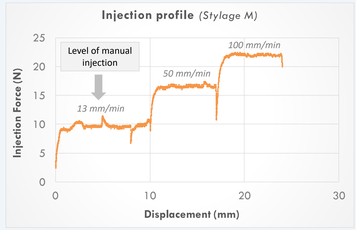
Injectability test: A needle was connected to the syringe containing the product and the injection profile was assessed using a traction bench (Mecmesin). A set of 3 compression speeds (13, 50 and 100 mm/minute) was successively applied to the piston rod and the resulting forces to extrude the product were measured.

RESULTS

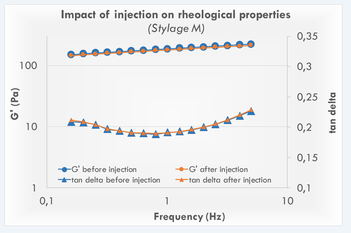
1- Characterization related to the injection procedure *(example with Stylage® M)*



✓ **Rheological profile identical at 25°C** (lab conditions) **and 37°C** (body temperature)



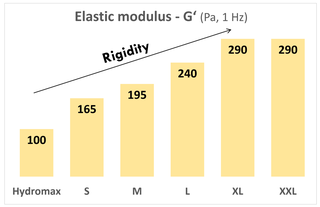
✓ **Steady injection profile** for each speed
→ Product homogeneity allowing a **regular injection**
→ **Spreading properties allowing an easy injection**



✓ Identical rheological profile before and after injection
→ **The product recovers 100% of its mechanical properties immediately after injection**

2- Rheological Characterizations related to the clinical performances: Key parameters

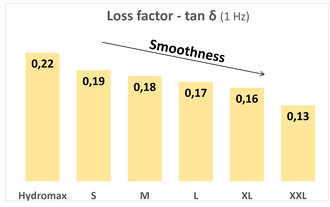
Elastic Modulus (G')
- Ability to maintain/return to its initial shape upon mechanical solicitation
- Characterize the **rigidity/elasticity of the product**
- **Capacity to project overlying tissues and to create volume**



✓ **Gradual increase of the rigidity** within the range

Meso: Low rigidity for an homogeneous distribution
Fillers: Rigidity increasing with the injection depth
Volumizers: High rigidity required to lift up overlying tissues and to restore volumes

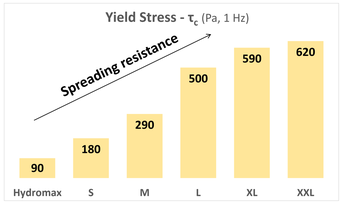
Loss factor (tan δ)
- Global viscoelastic property of the product
- Characterize the **smoothness of the product**
- **Ratio between adaptability and filling performance**



✓ **Slight decrease of the smoothness** of products within the range

Meso: High smoothness for an optimal adaptation to the superficial tissues
Fillers: Medium smoothness to reach a compromise between adaptability and filling performance
Volumizers: Lower smoothness to optimize the volumizing effect

Yield stress (τ_c)
- Spreading capacity : can be related to viscosity features
- Characterize the **resistance to flow**
- **Capacity to remain on the injection site**

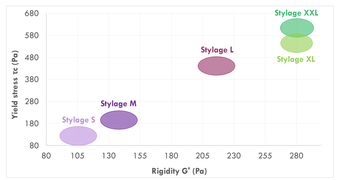


✓ **Increase of the spreading resistance** within the range

Meso: High spreading capacity to allow product nappage within the skin
Fillers: Spreading decreases along with the density of surrounding tissues
Volumizers: Low spreading for a high retention on site within loose subcutaneous tissues

CONCLUSIONS

✓ ***Smooth and comfortable injection for both the patient and the practitioner***
✓ ***Correlation between yield stress and rigidity:*** *Both parameters participate to the limitation of spreading and to the filling/projection capacity*



✓ ***Global rheological characteristics of products in accordance with the different clinical indications***

Mesotherapy
Injection plan: **close to the skin surface**
Product requirements: High **adaptability** to avoid visible irregularities
Rheological characteristics:
✓ **High smoothness & spreading capacity**
✓ **Very low Rigidity and Yield stress**

Fillers
Injection plan: Middle depth, **dense tissue**
Product requirements: **Compromise between strength and smoothness**
Rheological characteristics:
✓ **Increasing rigidity and yield stress** as the injection depth increases
✓ Conserving a **high smoothness**

Volumizers
Injection plan: **Loose tissue, very deep** (high skin thickness to support)
Product requirements: **Strong mechanical properties** to **support and project the skin**
Rheological characteristics:
✓ **High rigidity and yield stress**
✓ **Long-lasting projection effect**