Resource for Unit 4 Lesson 6 Dermal Fillers - Rheology

HA Dermal Fillers – How to Choose

As with neurotoxins there are a number of different brands/types of HA dermal filler available in the UK which have the requisite CE marking. How to choose which to use? This is an important skill for aesthetic practitioners and one of the reasons why you must be familiar with the chemical structure, function and manufacturing of HA dermal fillers.

We need to be able to identify the correct type of filler for the different indications in facial aesthetic practice.

Rheology,

This refers to the study and measurement of the flow and deformation properties of these fillers when subjected to various forces or stresses. It is a critical aspect of understanding how HA dermal fillers behave once injected into the skin.

Flow Behaviour:

Viscosity: Rheology helps characterize the viscosity of HA dermal fillers. Viscosity refers to the thickness or resistance to flow of the filler. Different HA fillers can have varying viscosities, from very thin and fluid to thick and gel-like.

Shear Thinning: Many HA dermal fillers exhibit a property called shear thinning, where the viscosity decreases as the shear rate (force or speed applied) increases. This is particularly relevant during injection, as the filler flows more easily under pressure, making it easier to inject smoothly.

Elasticity: Rheological testing assesses the elasticity of HA fillers. Elasticity refers to the ability of a material to return to its original shape after deformation. The elastic modulus quantifies this property and is crucial for understanding how the filler maintains volume and shape once injected.

Cohesivity: Cohesivity measures how well the molecules within the HA dermal filler are held together. Cohesive fillers have strong molecular bonds and tend to stay together, making them suitable for contouring and providing support.

Spreadability: Some fillers have lower cohesivity and spread more easily within the tissues, which can be desirable for certain applications, such as lip augmentation.

Yield Stress: Yield Stress: Rheology can also determine the yield stress of HA dermal fillers. Yield stress represents the minimum amount of force required to initiate flow or deformation of the filler. It's important in assessing how readily the filler responds to external pressures, such as during injection or tissue movement.

Natural-Looking Results: Rheology plays a role in achieving natural-looking results. Fillers that closely mimic the properties of natural tissue, including elasticity and cohesivity, tend to provide more harmonious and long-lasting outcomes.

Injection Techniques: Understanding the rheological properties of HA dermal fillers is crucial for healthcare professionals when selecting and applying fillers. Thicker, more elastic fillers may be preferred for deeper tissue augmentation, while thinner, more fluid fillers may be suitable for fine lines or superficial injections.

Product Customization:

Product Development: Manufacturers of HA dermal fillers use rheological testing during product development to tailor the properties of their fillers for specific clinical indications and patient needs.

Innovation: Ongoing research in rheology contributes to innovations in filler technology, leading to the creation of fillers with enhanced properties and application techniques.

In summary, rheology is a fundamental aspect of understanding how HA dermal fillers behave in response to forces and stresses. It encompasses viscosity, elasticity, cohesivity, yield stress, and other properties that impact the filler's performance and clinical applications. An in-depth understanding of rheology allows healthcare professionals to select the most appropriate filler for specific treatments and achieve optimal outcomes while ensuring patient safety and satisfaction.

The relationship between cross-linking and rheology

In the context of hyaluronic acid (HA) dermal fillers is a crucial aspect of understanding how the physical properties of these fillers are influenced by their chemical structure.

Cross-linking involves the formation of covalent bonds between individual HA molecules within the filler. These bonds connect HA chains, creating a three-dimensional network or lattice structure.

The primary purpose of cross-linking in HA dermal fillers is to enhance their durability and longevity. Cross-linked fillers are less susceptible to enzymatic degradation, which can extend their lifespan within the skin.

Relationship between Cross-Linking and Rheology:

Viscosity: Cross-linking increases the viscosity of HA fillers. Fillers with a higher degree of cross-linking have a thicker and more gel-like consistency. This impacts their flow behaviour during injection. Less cross-linked fillers are more fluid and less viscous.

Elasticity: Cross-linking also affects the elasticity of HA fillers. Highly cross-linked fillers tend to have greater elasticity and can better maintain their shape and volume after injection. This is important for achieving long-lasting results.

Shear Thinning: Cross-linked fillers may exhibit shear thinning behaviour, where their viscosity decreases as the shear rate (force applied) increases. This property can be advantageous during injection, allowing for smoother and more controlled delivery.

Cohesivity: Cross-linked fillers often have higher cohesivity. Cohesivity refers to the ability of the filler to stay together as a cohesive mass after injection. This property is important for preventing filler migration and achieving precise results.

Yield Stress: Cross-linking can influence the yield stress of HA fillers, which represents the minimum force required to initiate flow. Cross-linked fillers may have a higher yield stress, making them less likely to deform under normal tissue pressures.

Duration of Effect: The rheological properties of cross-linked HA fillers contribute to their longer duration of effect. Their increased viscosity, elasticity, and resistance to enzymatic degradation result in sustained volumizing and wrinkle-smoothing effects.

Clinical Considerations: Healthcare professionals select HA dermal fillers based on their rheological properties, considering the degree of cross-linking and the specific clinical indications. Thicker, more elastic, and highly cross-linked fillers are often used for deeper tissue augmentation, while less cross-linked and more fluid fillers are suitable for finer lines and superficial injections.

High and Low Molecular Weight in HA Dermal fillers

The molecular weight of hyaluronic acid (HA) is a critical factor that influences the properties and clinical applications of HA dermal fillers. High and low molecular weight HAs have distinct characteristics and implications for their use in aesthetic and medical treatments.:

High Molecular Weight HA:

Definition: High molecular weight HA refers to HA molecules with larger sizes, typically consisting of longer chains of repeating disaccharide units (glucuronic acid and N-acetylglucosamine).

Implications:

Hydration and Viscosity: High molecular weight HA has excellent water-holding capacity. It can absorb and retain a significant amount of water, contributing to tissue hydration and volume.

Viscosity: These fillers tend to be highly viscous and have a thick, gel-like consistency. The viscosity makes them suitable for providing volume and structure to areas with deep tissue loss or hollowing.

Duration of Effect: High molecular weight HA fillers often have a longer duration of effect due to their slower degradation rate. The larger molecules are more resistant to enzymatic breakdown.

Clinical Applications:

Volume Restoration: High molecular weight HA fillers are commonly used for deep tissue augmentation and restoring lost volume in areas like the cheeks, temples, and jawline.

Sculpting and Contouring: They are also preferred for sculpting and contouring procedures, where precise placement and stability are essential.

Low Molecular Weight HA:

Definition: Low molecular weight HA consists of smaller HA molecules with shorter chains.

Implications:

Hydration and Viscosity: Low molecular weight HA still has some water-holding capacity but to a lesser extent compared to high molecular weight HA.

Viscosity: These fillers are less viscous and more fluid, making them suitable for fine lines, superficial injections, and areas where a smoother, lighter texture is desired.

Duration of Effect: Low molecular weight HA fillers tend to be metabolized more quickly by the body due to their smaller size, resulting in shorter durations of effect.

Clinical Applications:

Fine Lines and Wrinkles: Low molecular weight HA fillers are ideal for treating fine lines and superficial wrinkles, such as crow's feet and perioral lines.

Lip Augmentation: They are commonly used for lip augmentation to achieve natural-looking results with enhanced definition.

What determines molecular weight in HA dermal fillers

The molecular weight of hyaluronic acid (HA) in dermal fillers is determined during the manufacturing process. Several factors and techniques can be used to control and modify the molecular weight of HA to achieve the desired characteristics for specific clinical applications.

Source of HA:

The starting material for HA dermal fillers can be obtained from various sources, including bacterial fermentation, animal tissues, or bioengineered sources.

The source can influence the initial molecular weight of HA, as different production methods may yield HA molecules of varying sizes.

Hydrolysis and Purification:

HA is often subjected to hydrolysis, a chemical process involving the breaking of HA chains into smaller fragments. This step is used to control the molecular weight.

The degree of hydrolysis can be adjusted to obtain HA molecules of the desired size.

Fractionation and Filtration:

Fractionation and filtration techniques are used to separate HA molecules based on their size.

These methods involve the use of specific filters or membranes with defined pore sizes to selectively retain HA molecules of a certain molecular weight range.

Cross-Linking Process:

The molecular weight of HA can be affected by the cross-linking process used during filler manufacturing.

Cross-linking can cause the HA chains to link together, creating a three-dimensional network. Depending on the cross-linking method and agents used, it can influence the size and properties of the resulting HA molecules.

Degree of Cross-Linking:

The degree of cross-linking is a critical factor in determining the molecular weight of HA in dermal fillers.

A higher degree of cross-linking can result in larger, more complex HA molecules, while a lower degree of cross-linking may lead to smaller HA molecules.

Quality Control:

Manufacturers of HA dermal fillers conduct rigorous quality control tests to ensure that the molecular weight of the HA meets specific standards and falls within the desired range.

These quality control measures help maintain consistency and product reliability.

Customization for Clinical Indications:

Manufacturers may produce HA dermal fillers with varying molecular weights to cater to different clinical indications and treatment goals.

For example, fillers with higher molecular weights are often used for deep tissue volumizing, while those with lower molecular weights are suitable for fine lines and superficial injections.

Innovation and Research:

Ongoing research and development in the field of HA dermal fillers lead to advancements in manufacturing techniques, allowing for greater control over molecular weight and other filler properties.

Non-Crosslinked HA products for injection

Non-crosslinked hyaluronic acid (HA) is commonly used as a skin booster in aesthetic medicine to improve skin hydration, texture, and overall quality. Skin boosters are injectable treatments designed to rejuvenate the skin and provide a natural, radiant appearance.

Improved Skin Hydration:

One of the primary effects of non-crosslinked HA is the enhancement of skin hydration. HA is a naturally occurring molecule in the skin that attracts and retains water.

When non-crosslinked HA is injected into the skin, it acts like a sponge, drawing in moisture and increasing the skin's water content.

This enhanced hydration results in plumper, smoother, and more supple skin.

Softening of Fine Lines and Wrinkles:

Non-crosslinked HA can help soften the appearance of fine lines and superficial wrinkles, especially those caused by skin dehydration.

By restoring optimal hydration levels, these lines become less noticeable, creating a more youthful appearance.

Enhanced Skin Elasticity:

Improved skin hydration can contribute to increased skin elasticity.

Elasticity is crucial for skin that looks firm and youthful, and non-crosslinked HA helps support this quality.

Reduction in Skin Roughness:

Non-crosslinked HA can improve skin texture by reducing roughness and irregularities.

The skin may feel smoother and more refined.

Mode of Action:

Hydration: Non-crosslinked HA acts as a humectant, attracting and binding water molecules to itself. This significantly increases the moisture content of the skin.

Stimulation of Collagen and Elastin: Some studies suggest that non-crosslinked HA may stimulate the production of collagen and elastin in the skin over time. These proteins are essential for maintaining skin structure and elasticity.

Bio revitalization: Non-crosslinked HA is often referred to as a bio revitalizer because it promotes skin rejuvenation from within.

When injected into the skin's superficial layers, it provides a reservoir of hydration.

Over time, this hydration can stimulate natural skin processes, leading to improved skin quality.

Microinjections: Non-crosslinked HA is typically administered using a microinjection technique. The HA is evenly distributed in small amounts across the treated area, ensuring a natural and subtle enhancement.

Gradual Improvement: The results of non-crosslinked HA treatments are usually gradual, with optimal outcomes achieved after a series of sessions spaced a few weeks apart. This gradual approach allows for a subtle, natural-looking transformation.

In summary, non-crosslinked HA as a skin booster acts by increasing skin hydration, improving elasticity, softening fine lines, and enhancing overall skin quality. Its mode of action involves attracting moisture, stimulating collagen and elastin production, and promoting bio revitalization. The results are subtle and gradual, contributing to a refreshed and rejuvenated appearance without the need for more invasive procedures.