The engineered structure based ability of a highly charged absorbent (polyacrylate) dressing* to adhere to slough like material in a preferential way compared to other absorbent fibers found in advanced dressings

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INTRODUCTION

Urgo Medical has developed UrgoClean®, a range of dressings composed of poly-absorbent fibres, whose unique feature is to ensure very strong adhesion in relation to the reconstituted fibrin during in vitro tests (see below).

On the Advanced Wound Care market, other products also used on wounds in the desloughing phase, such as alginates and hydrofibres, are also under the form of absorbent fibrous compresses with a gelling action when in contact with exudate, without however creating adhesion with the reconstituted fibrin during in vitro tests.

The aim of this study is to explain why UrgoClean® provides this adhesion and what physical and chemical phenomena are involved. Two physical and chemical phenomena are investigated: absorption + the physical and chemical interactions between the biomaterials.

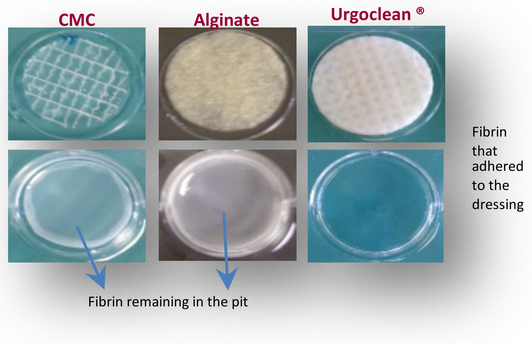
RESULTS

INTERACTION WITH A FIBRIN GEL RECONSTITUTED *IN VITRO*

- UrgoClean® shows a very strong affinity with fibrin gel reconstituted in vitro, taking the form of adhesion between the two materials.
- The other two CMC and alginate dressings did not show any adhesion in spite of gelification of the fibres and a similar absorption level.

The results of the slough/fibrin gel adhesion study are shown in Figure 1

FIG 1: Evaluation of the adhesion of dressings to a fibrin gel reconstituted in vitro



The dressing samples were applied to fibrin reconstituted in vitro (based on fibrinogen and human thrombin), and a weight was applied in order to simulate a dressing subjected to compression at a level of 40 mmHg.
The weight was removed after 30 sec. The final adhesion was evaluated after 24-hr incubation at room temperature. 5 samples were evaluated per dressing.
A representative image is shown here.

ELECTROSTATIC INTERACTIONS

The main physical and chemical interactions between biopolymers are:

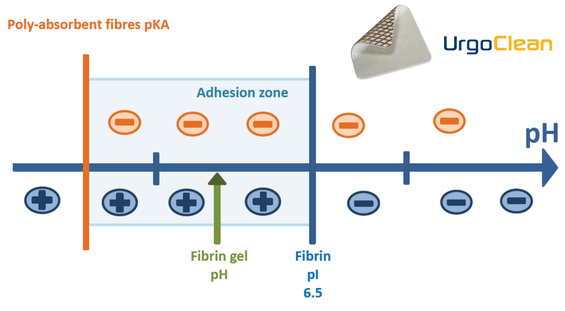
- Steric exclusion
- Hydrophobic interactions
- Hydrogen bonds
- Electrostatic interactions: the most intense interactions for biopolymers presenting an electrical charge in the environment where they are used. They attract or repel depending on whether the charged groups have the same symbol or the opposite symbol.

In this study, the materials carry ionic charges in an aqueous medium and are particularly sensitive to these electrostatic interactions.

HYPOTHESIS FOR ADHESION OF THE FIBRIN GEL:

- **UrgoClean® poly-absorbent fibres:** Ammonium polyacrylate which, throughout its chain, presents COO- and COOH groupings: Depending on the material's pKa, there is a higher density to a greater or lesser exent depending on the pH.
- **Fibrin:** A protein showing two types of charged groups due to its protein nature: NH+ and/or COO-: the protein's overall charge depending on the environment's pH is determined via its isoelectric point (pI), which is comparable to the nil charge point.

FIG 2



When pH < pI, there is a negative charge (COO- groupings)

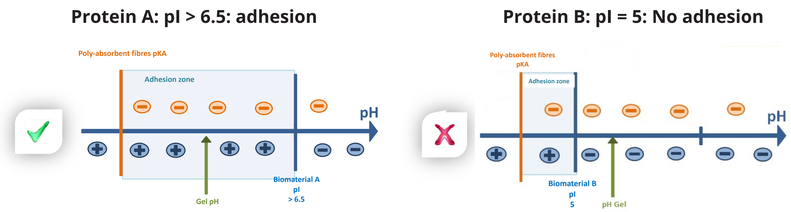
When pH > pI, there is a positive charge (NH+ groupings)

There is a pH interval in which the fibrin exists in (+) form and the polyacrylate in (-) form: it is in this space that electrostatic interaction with a very high intensity is created, taking the form of the phenomenon of adhesion of the material to the fibrin gel.

DEMONSTRATION OF THE EFFECT OF THE ELECTROSTATIC INTERACTIONS WITH BIOMATERIALS WITH KNOWN ISOELECTRIC POINTS

Two gelling proteins with different isoelectric points make it possible to investigate whether the electrostatic interactions are indeed the predominant phenomenon in the adhesion.

FIG 3



THE IMPORTANCE OF CAPILLARITY

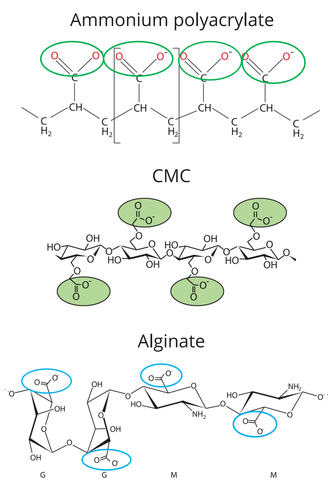
Electrostatic adhesion requires the contact surface between the biomaterials to be as large as possible. This is done via capilliary absorption of the poly-absorbent fibres pad. Indeed, when the two materials are brought into contact, there is:

- No adhesion between two dry materials
- No adhesion between two wet materials
- Adhesion between a dry material and a wet material

THE IMPORTANCE OF THE CHARGE DENSITY

If you compare them to ammonium polyacrylate (UrgoClean® poly-absorbent fibres), the chemical structures of the CMC and of the alginate show a much lower density in terms of negative charges. The electrostatic interactions resulting from these materials' contact with a fibrin gel are consequently much weaker, and are insufficient to cause an adhesion phenomenon to the fibrin gel, with this being the case in spite of the equivalent capillary absorption capacities.

FIG 4. Poly-absorbent fibers



CONCLUSION

Two characteristics are required to create an interaction that is sufficiently strong to cause the phenomenon of adhesion by UrgoClean® poly-absorbent fibres to the fibrin in vitro :

- Very close contact between the fibrin molecules and the poly-absorbent fibres, due to the absorption and capillarity of the UrgoClean® pad.
- The implementation of very strong electrostatic interactions due to the high density of negative charges on the poly-absorbent fibres and the positive charge of the fibrin chains at the pH used for the implementation of the test.

These interaction characteristics and the clinical proof in the desloughing phase show a very specific method of action of the poly-absorbent fibres in relation to the fibrin. Future investigations will enable us to better understand these phenomena and to elucidate the method of operation of the range of UrgoClean® dressings in the desloughing phase, which is so unique.