EVALUATION OF IN-SITU ELECTROSPUN NANOFIBER SCAFFOLDS IN HARD-TO-HEAL WOUNDS

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Introduction

Hard-to-heal wounds are common and challenging to treat due to infections, complications, and chronicity, resulting in increased health care cost.

At our clinic the management of hard-to-heal wounds is common due to referrals from other hospitals who have failed to heal the wounds.

We have recently started to evaluate treatment of hard-to-heal-wounds with an in-situ electrospun nanofibrous matrix.

Aim

Evaluate an in-situ electrospun nanofiber scaffold in terms of wound healing, reduction of exudate, odour, wound size, infection and pain.

Method

Target population included residents residing in the Rehabilitation Centre and clients visiting the wound clinic. Convenience sampling was used based on availability to the researcher.

12 patients with hard-to-heal wounds, with an average duration of 32 months were included. 3 recurring VLU, 1 DFU and 8 PU.

A thorough medical and social assessment of the patient's history, concerns, and a detailed wound assessment based on the TIMERS principle was performed. Education of both the patient, patients' family and nurses was part of the treatment plan.

A fully synthetic nanofibrous matrix was in-situ printed on the wounds and covered with an atraumatic non-stick wound contact layer (WCL) and/or a non-adherent absorbent dressing in conjunction with supporting therapies (offloading, compression, etc.). This matrix acted as a scaffold, presumably facilitating increased migration and proliferation. Secondary dressings were exchanged on a regular basis and sometimes as needed, while the matrix was maintained on the wound. Reapplication of the matrix was done according to need.

Results

All hard-to-heal wounds included in the evaluation were previously treated unsuccessfully with other advanced wound care products such as collagen, silver, and silicon-foams. No infections were registered after being treated with the matrix printed in-situ, despite all patients in the past being treated with i.v. antibiotics due to recurrent infections.

The in-situ electrospun scaffold provided a nanofibrous protective barrier to the wound environment. Its high porosity has helped to maintain the optimal wound environment with moisture balance enhancing the healing process. Cost effectiveness provided by savings in nursing time and increased healing rates.

All the patients showed a gradual reduction of wound size. Depending on wound size, healing was achieved between 3 to 12 weeks. Both odour and exudate levels reduced almost immediately. Peri-wound skin improved by 75% in 2 weeks on all wounds. In general, the patient pain levels reduced significantly from 6 to 3 after a week, to 0 after 3 weeks (VAS scale).

In the VLU group (3 patients), there was a distinct decrease in the use of analgesia by the end of the seven days, allowing the patients to be more alert and active during the day. We have not seen any recurrence of the wounds after a follow-up of 3 months.

In the case of the DFU we can argue that wounds do not heal with dressings but start to epithelise when the cause of chronicity is resolved. By using a nanofibrous scaffold on the wound, we noted the speed of epithelialisation, the edges of the wound showed quick migration of cells thus enhancing the healing process.

Discussion

The following observations were made during the application of the matrix:

It is important that the nurses are trained to visualize the transparent matrix on the wound bed. Initially it can be difficult to visualize the matrix on the wound bed and occasionally the matrix was accidentally removed, resulting in a new one having to be applied. What we have learned is that by examining the peri-wound area and the wound edges we could see the matrix as a thin protective layer stuck on top of the wound.

We also found that when the matrix does not turn transparent after the application, it is beneficial to gently press down the matrix on the wound surface to ensure complete contact to the wound surface.

The type of secondary dressing used to protect the nanofibrous scaffold is crucial. If secondary dressing sticks to the scaffold, it is likely to also remove scaffold when changed. Wound contact layers MUST be non-sticking. It is important to be able to clean and disinfect on top of the WCL even in cases of faecal incontinence, maintaining the scaffold without disturbing the healing process. This is especially important as it takes about 48 hours for the matrix to bond strongly to the wound surface. The pores of the non-adhesive WCL should be shaped and arranged in a way that it allows the exudate to pass through without clotting.

Very promising observations and assessments in our small evaluation indicate that in-situ electrospun nanofiber scaffolds may be an important tool for accelerating healing of hard-to-heal wounds, while also decreasing the risk of infection. More research is needed to statistically confirm our findings.

Bibliography

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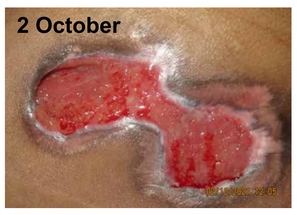
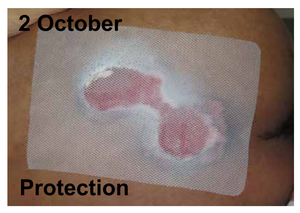
30-year-old male, malnourished (in spite of prescribed protein drinks), with a tracheostomy, who has been in the ICU for six months following a traffic accident. During this time, he developed multiple pressure injuries on his sacrum, trochanters, malleolus and heels. Duration of most wounds was 18 months.

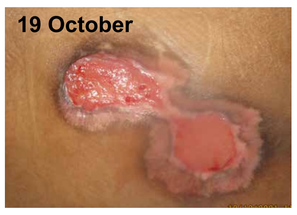
Pain at dressing changes around 8 (VAS) so analgesia was needed prior to dressing changes.

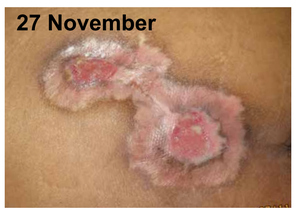
Previous treatments included alginates, silicone foams and collagen, with daily dressing changes.





Scaffold applications
2 October
19 October
27 November





Photos on the left show the wound at time of the 2nd and 3rd scaffold application.
Photo to the right shows the healed wound.

The pain level dropped to 3 (VAS) after application of the electrospun nanofibrous matrix, so analgesia was no longer needed. After application, the electrospun nanofibrous matrix was covered with a protective non-stick layer as well as a superabsorbent pad, (the pad was to absorb eventual leakage of feaces). We only needed to change the superabsorbent pad on a weekly basis. After 3 weeks the pain level dropped to 0. The 18-month-old wound healed in 3 months.

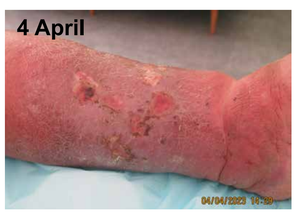
99-year-old female on constant 0xygen flow of 2 liters/minute due to COPD. History of CVAs. Has an NG tube in the last 2 years. Other than that, the patient is alert and verbal. Recurring pressure injuries on the ears due to pressure from the tube. This current pressure injury has been open for six weeks. Previous treatments included hydrogels and hydrocolloids.

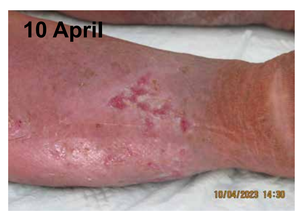
Only one application of electrospun nanofibrous matrix was needed, the wound was closed 8 days later. Follow-up six months after healing the wound was still closed showing that the new epithelialization retained its elasticity. Nothing has changed in her condition or care provided.

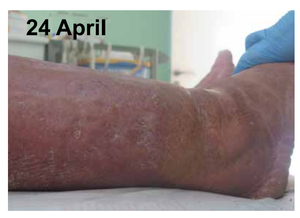
77-year-old male with small (3x3 cm) highly exuding wounds on both legs caused by venous insufficiency and lymphedema. In spite of having received lymphatic drainage and compression three times a week by a lymphedema specialist the wounds were getting worse.

The wounds had been open for five months before was referred to our clinic by his GP.

Previous treatments include silicon foams and super absorbent dressings.

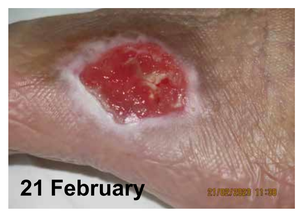


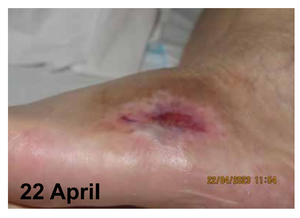




A single treatment with with electrospun nanofiber scaffold was performed on the 23 of March. Due to the high exudation the wounds were covered with a super-absorbent dressing with a built-in wound contact layer that does not adhere to the matrix. Lymphatic drainage and compression still continue as part of his regular treatment.
Complete closure by the 21st of April (photo taken on the 24th April).

72-year-old male with uncontrolled diabetes and neuropathy developed a PU from using ill-fitting shoes. Various treatments were used, collagenase enzyme for debridement, Hyaluronic acid, hydrofibers and alginates. Duration of wound five months.





Eight weeks after we applied the first electrospun nanofibrous matrix on the the wound it had closed. A total of four applications were needed. A silicon based wound contact layer and non-woven gauze was used on top of the matrix. Since the wound was relatively dry it would have been enough to change the secondary dressings once a week. Due to the insecurity of the patient and his nurses they opted to change every other day. Our impression was that this scaffold matrix help to provide the environment for the wound to turn from chronic characteristic to an acute one towards completion of the healing process.

Word 'patient' was used throughout for ease of readers. I do not like the word 'patient' as it is a stereotype, and in my world people are not patients, but rather are clients or residents. 'Patients' are people who are in the hospital. As soon as they are discharged, they give up this role. It is all about psychology of our residents or clients. They do not take the role of the sick person.

In-situ electrospun nanofibrous matrix was applied with the use of Spincare™ - Portable Wound Care System, manufactured by Nanomedic Technologies Ltd. This is an unsponsored evaluation.