# First experiences with a novel epidermal harvesting system in a Singaporean vascular surgical unit: two patients with chronic wounds due to limb ischaemia







The CelluTome™ Epidermal Harvesting System (Acelity) has recently been touted as a promising alternative to traditional skin grafting for chronic wounds, and can be performed without anaesthesia in the outpatient setting with minimal to no pain. A chronic wound is usually defined as any wound that has not healed for six weeks or more. Slow and prolonged wound healing may be due underlying disorders, such as chronic venous insufficiency and diabetes mellitus (diabetic foot ulcer from microvascular disease), dermatological conditions (e.g. pyoderma gangrenosum and calciphylaxis) and peripheral arterial disease (i.e. critical ischaemia secondary to macrovascular disease). There is fairly little information in the literature detailing the use of CelluTome, specifically in peripheral arterial disease. Almost all articles focus on venous ulcers, diabetic foot ulcers (without mention of peripheral arterial disease) or trauma, with very few exceptions. This article outlines our department's first use of CelluTome in two patients with critical limb ischaemia, resulting in slow-healing foot wounds despite angioplasty and multiple cycles of vacuum dressings. Both experienced 100% graft takes with full wound closures. CelluTome appears effective in achieving rapid wound closure in patients with critical limb ischaemia.

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The CelluTome™ Epidermal Harvesting System (Acelity) was first launched in 2013 by Kinetic Concepts Incorporated (KCI). It is marketed as a system that is intended to be easily integrated into existing clinical practice using an automated, precise and reproducible process to harvest thin autologous epidermal skin grafts, with minimal pain and donor-site trauma.

Our department is a busy vascular surgical unit in Singapore, which performs open and endovascular revascularization procedures, foot wound debridement and outpatient wound-care. We describe herein our first experiences with the CelluTome System in two patients who had persistent, non-healing foot wounds despite endovascular revascularization. Both patients achieved complete wound closure within 4 to 6 weeks of CelluTome application.

## CASE 1

Mr LTM, a 46-year-old Chinese male, had a past medical history of type II diabetes mellitus, haemodialysis-dependent end-stage renal failure, hypertension, hyperlipidaemia, ischaemic heart disease and peripheral vascular disease and a below-knee amputation (left) four years ago. He was community ambulant, used a motorized wheelchair and still smoked when he presented with right foot cellulitis and an ulcer over the lateral aspect of the fifth toe base.

Arterial duplex sonography showed segmental proximal stenosis and chronic total occlusion of the mid right superficial femoral artery (SFA), as well as a long segment occlusion of the anterior tibial artery *[Figure 1]*. Toe pressures were undetectable.

He was admitted to our unit, commenced on intravenous antibiotics and underwent and an urgent right lower limb angioplasty.

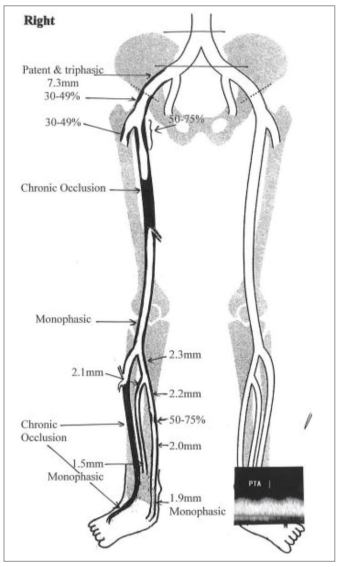


*Figure 1. Arterial duplex of the affected right lower limb*

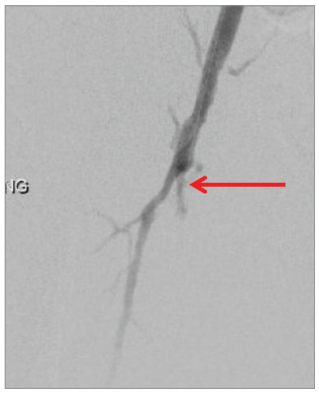

*Figure 2a. Severe stenosis of SFA origin (arrowed)*

*Figure 2b. CTO of SFA at mid-thigh with distal reconstitution (bracket)*

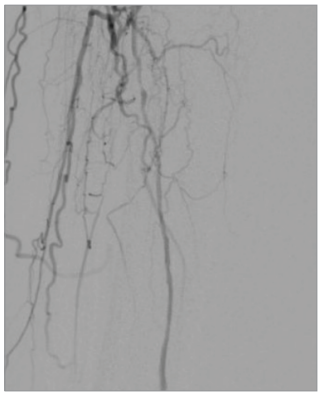

*Figure 2c. Complete occlusion of ATA, proximal disease of PTA*

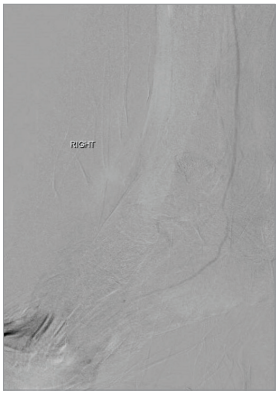


*Figure 2d. Single PTA supply to foot*

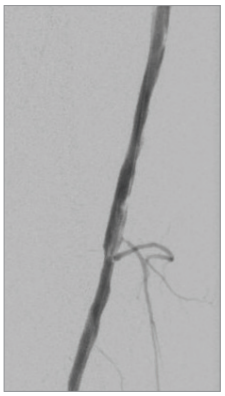

*Figure 3a. SFA after successful recanalization*


*Figure 3b. Improved proximal PTA*


*Figure 4a. Post-revascularization lateral foot view*


*Figure 4b. Anteroposterior foot view*

*Figure 5. Sloughy, non-healing right foot wound despite angioplasty and debridement with exposed 5th metatarsophalangeal joint capsule*

*Figure 6. Markedly improved wound after conversion to VAC with Veraflo therapy*

Retrograde access was achieved via the left common femoral artery and the aortic bifurcation was crossed. Angiography showed patency of the right common, external and internal iliac arteries. The SFA had a severe 80% stenosis near its origin *[Figure 2a]* with a 15cm-long complete total occlusion (CTO) at the mid-thigh *[Figure 2b]* in concordance with the arterial duplex findings.

There was a focal severe stenosis of the tibial-peroneal trunk and several stenoses of the proximal posterior tibial artery. The anterior tibial artery was completely occluded without reconstitution *[Figure 2c]*. Flow to the foot was via the posterior tibial artery *[Figure 2d]*.

The SFA CTO was crossed subintimally and recanalized with plain old balloon angioplasty (POBA). A non-flow-limiting dissection was further treated with prolonged balloon inflation and the result accepted *[Figure 3a]*. The tibial-peroneal trunk and posterior tibial artery were also angioplastied with good result *[Figure 3b]*.

Lateral and anteroposterior foot runs showed improved flow to the lateral foot *[Figure 4a and 4b]*.

Post angioplasty, toe pressures were 39 mmHg. He was discharged with daily Povidone-soaked gauze dressing and followed up weekly

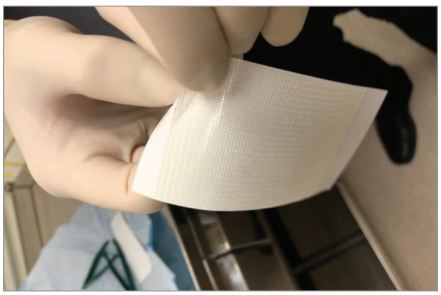

*Figure 7a. Adaptic Touch dressing prior to loading the graft.*

*Figure 7b. Applying the Adaptic Touch dressing loaded with harvested epidermal graft basal-side-down onto the wound bed.*

*Figure 7c. Post application of the Adaptic Touch dressing to the wound bed with maximal apposition*

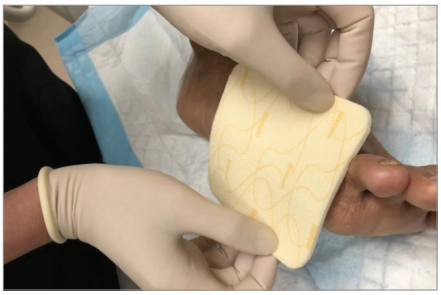

*Figure 7d. Applying protective Biatain® Soft hold as secondary dressing.*

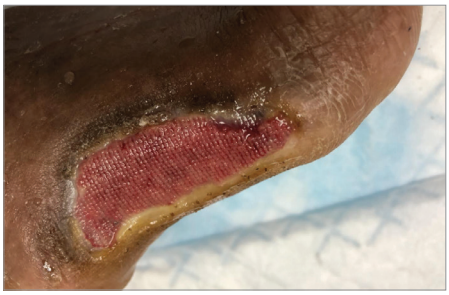

*Figure 8. 1 week post application of CelluTome epidermal graft showing full take of blister grafts to the wound bed*

*Figure 9. 2 weeks post application of CelluTome graft demonstrating neo-epithelialization*

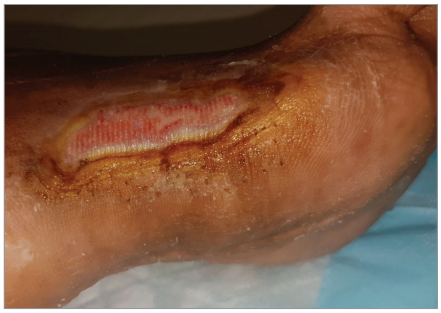

*Figure 10. 3 weeks after application of CelluTome graft showing the wound contracting circumferentially and epithelializing centrally*

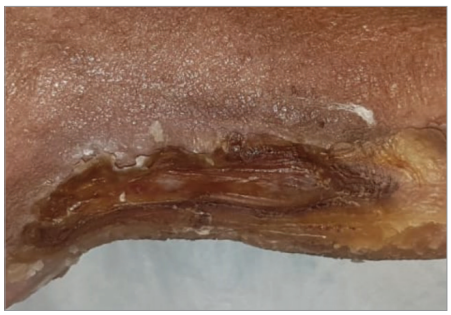

*Figure 11. Four weeks post application of CelluTome — complete healing.*

*Figure 12. 2 months after application of CelluTome*

in clinic but his wound remained static and had become sloughy and malodorous a fortnight later at which point he was re-admitted for wound debridement. His wound again failed to heal and gradually enlarged and deepened over the next month until the metatarsal head and capsule of the metatarsal joint were exposed *[Figure 5]*.

He underwent fifth toe ray amputation, followed by two weeks of ActiVAC therapy but his wound remained static and sloughy, requiring frequent bedside debridement. Therapy was escalated to V.A.C. ULTA with Veraflo therapy, using normal saline as irrigant, whereupon the wound made marked improvement *[Figure 6]*. He was converted to ActiVAC therapy a month later and discharged home.

A further three weeks later, the wound bed was granulating well but wound contraction was slow. The wound measured 5.5 cm x 3.1 cm, compared with 6.4 cm x 3.8 cm immediately after the ray amputation, some two months prior. At this point, the wound had been present for four months. Options for accelerating closure were discussed including split skin grafting and the CelluTome™ system, and Mr LTM opted for the latter as it could be performed and followed-up in the outpatient setting.

We performed this in our clinic as follows:

- The CelluTome Harvester was securely strapped to the patient's prepared ipsilateral thigh and activated to begin raising microblisters under suction and heat. After 45 minutes, the blisters had formed and were cut, using the inbuilt blade mechanism, the vacuum head was disengaged and the domes transferred to an Adaptic Touch™ (Acelity) non-adherent silicone dressing


*Figure 13. Chronic wound at base of 1st metatarsal (left), with full resolution 6 weeks after CelluTome (right)*

which was applied basal-side-down onto the recipient wound bed. Finally, a secondary dressing was done with an Biatain® Soft hold (Coloplast) secured in place with a crepe bandage *[Figure 7a–d]*. Remarkably, the patient did not experience any pain during the harvesting process.

- A further week later neo-epithelialization was macroscopically visible between blister grafts, and the edges of the wound were also epithelializing rapidly *[Figure 9]*
- A further week later the wound had to 4 cm x 8 mm and epithelialization was well underway *[Figure 10]*.
- A week later the wound had fully epithelialized, although there was an overlying scab which was softened with daily application of olive oil. Complete healing had been achieved in four weeks after CelluTome application *[Figure 11]*.
- Two months later the scab had largely resolved *[Figure 12]*.
- At the time of writing the foot wound remains fully-healed thirteen months after application of CelluTome.

## Case 2

Mr MK, a-59-year old Indian male, presented with type II diabetes mellitus, hypertension, hyperlipidaemia and known peripheral vascular disease with previous right lower limb angioplasty with 2nd and 3rd toe ray amputations for toe gangrene seven years ago. He developed an ulcer over the base of the right big toe four years later. X-rays and MRI scans showed active osteomyelitis of the first metatarsal head. Arterial duplex showed re-occlusion of the previously treated tibioperoneal (TP) trunk with new stenoses of the distal posterior tibial artery, and arteriovenous shunting at the great toe resulting in incomplete filling of the plantar arch and poor filling of the plantar arteries. Angioplasty to the TP trunk as well as to the distal posterior tibial artery was performed resulting in brisk flow to the plantar arteries and restoration of a complete plantar arch. He refused big toe amputation and was treated with ActiVAC therapy and 6 weeks of intravenous antibiotics. An X-ray a year later showed resolution of the osteomyelitis. During this time, the wound base granulated but failed to epithelialize and remained static at 1.5 cm diameter. CelluTome was applied using the same technique described above coupled with offloading of the wound, using an irremovable cast walker (Scotchcast™ (3M) coupled with an Aircast® (DJO Global)). There was full wound closure by 6 weeks *[Figure 13]*.

## Discussion

A fair number of authors have described the successful use of the Cellutome system in the outpatient setting to treat vitiligo, venous ulcers, mixed arteriovenous ulcers and burns (Vinceneux Talvande et al, 2018; Joethy et al, 2019). Only a few have written about its use in chronic wounds (Cai et al, 2016; Fearmonti, 2016) and fewer still have described applying it to chronic foot wounds, secondary to critical limb ischaemia. Fearmonti et al (2016) achieved re-epithelialization of an ulcer over the Achilles tendon which had initially failed to heal a fortnight post revascularization. The ulcer healed six weeks after application of a combination of CelluTome and a regenerative tissue matrix. Cai et al (2016) used CelluTome to achieve complete resolution in a patient who

## References


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had experienced breakdown of an above-knee amputation stump after vascular graft failure, and partial resolution in a patient with mixed arteriovenous disease who developed a lower extremity wound after vascular graft failure.

It is striking that PubMed searches for "CelluTome" OR "Epidermal Graft" AND "Peripheral Arterial Disease", and "CelluTome" OR "Epidermal Graft" AND "Critical Limb Ischaemia" produce no relevant results, but perhaps this is unsurprising considering that all articles to date have been contributed by plastic surgeons and dermatologists without input from vascular surgeons, who tend in many parts of the world to focus their efforts on revascularization and entrust the responsibility of wound care to plastic and podiatric surgeons.

In contrast, vascular surgeons in Singapore both revascularize limbs as well as perform wound care for patients with critical limb ischaemia, and are usually the attending physicians during wound-related hospital admissions. Wound care often involves protracted hospital stays, frequent debridement and costly durations of topical negative pressure wound therapy, especially when wounds tend towards chronicity.

With regards to revascularization, we tend to perform endovascular interventions as many of our patients are non-ambulant, medically frail and poor candidates for bypass surgery. When performing angioplasty, we adopt an angiosome-targeted revascularization strategy aimed at achieving straight in-line perfusion to the wound bed as this is thought to be optimal for wound healing. Where ischaemic tissue burden is large, multiple tibial artery revascularization is intuitively attractive in order to increase blood volume flow to the foot (Younes and Shishehbor, 2019). While the primary goal of revascularization is to provide maximal and sustained blood flow directly to the wound bed (Kirksey and Troiano, 2011) in order to optimize healing, complete wound healing often takes many months and endovascular interventions have limited durability. The large majority of Singaporean patients have infrapopliteal disease (Mo et al, 2013; Lo et al, 2018) (secondary to high rates of diabetes and renal failure) and angioplasty to tibial and plantar lesions tends to reocclude quickly, often before the index wounds have fully healed. Our experience is that foot wounds (as opposed to calf and ankle wounds) are especially slow to heal when straight in-line wound perfusion is unattainable, when there is involvement of the heel, and when gangrene, abscess or osteomyelitis are present resulting in large, deep post-surgical wounds. The latter is all too-often the case in our elderly Asian patients who tend to present late after first consulting and dallying with practitioners of traditional medicine. For these reasons techniques or technologies that accelerate our patients' wound closures and reduce their chances of secondary infection from open ulcers, as well as expedite their return to premorbid function are highly desirable to us.

The Cellutome System is attractive to patients because the procedure is performed in the outpatient setting with only minor discomfort, and appears to have good clinical outcomes. There is a glaring gap in the literature with regards to patients with critical limb ischaemia-associated foot wounds, perhaps due to fact that such wounds are amongst the most challenging to treat and unattractive for proof of concept because of their tendency towards chronicity and non-healing. Even though these patients may stand to gain the most as they almost always harbour multiple medical comorbidities, have already experienced prolonged hospitalizations and, like Mr LTM, are weary of undertaking further surgeries. Like Mr MK, a number of patients may have developed unshakeable pre-conceptions that further surgery will only lead to further amputation. Both our patients were extremely receptive towards CelluTome despite being made aware that treatment failure rates could be as high as 30% (Kanapathy et al, 2017). We were impressed by the simplicity and painlessness of the harvesting and application process, and the speed and completeness of wound closure in both patients, both of whom had chronic wounds that had effectively stalled. There is a need for more well-designed studies to further evaluate CelluTome in our Southeast Asian patients with chronic foot wounds from critical limb ischemia, both to establish its efficacy as well as improve our understanding of factors relating to optimal patient selection and wound bed preparation for the therapy. WAS