

## Total contact casting: a South African approach to offloading the diabetic foot

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Wound Healing Southern Africa 2016;9(1):19-24

Foot ulceration is the most common complication associated with those living with diabetes. Total contact casting (TCC) is regarded as the gold standard offloading method in aiding rapid healing of neuropathic plantar foot ulcers,<sup>1,2</sup> and numerous studies and papers indicate its effectiveness.<sup>1-4</sup> Several TCC methods are used worldwide, the most well-known being the application of TCC with plaster bandage, as described by Levin and O' Neal.<sup>1</sup>

However, TCC is still under-used in South Africa, and other offloading devices, such as felt padding of shoe inserts, are primarily used.<sup>5</sup> The reasons for this have been discussed by the authors and healthcare professionals working in this area and, anecdotally, it appears that the most common reason for not using TCC seems to be 'fear of failure'; health professionals are uncertain how to apply TCC and are worried that it will cause more harm than good. It is, therefore, clear that guidance, education and skills training are needed to change this perception in South Africa.

Several studies have shown that TCC in skilled hands is safe for the patient.<sup>2,6</sup> Howard described the use of the Scotchcast™ (3M), which has been widely adopted in South Africa.<sup>5</sup> The purpose of this article is to demonstrate why and how the authors, working from two independent outpatient centres that treat patients with diabetic foot ulcers in South Africa, introduced a new TCC system, to meet the needs of the South African patient group.

### Why total contact casting?

- TCC is used in neuropathic ulcers to:
- Offload pressure: it reduces pressure on the plantar aspect while walking by 84% to 92%<sup>1,7</sup>
- Increase the total surface area of the mid-foot and forefoot during weight bearing, thereby, reducing peak pressures<sup>1,7</sup>
- Shorten the wound healing time, while enabling more mobility for the patient<sup>7</sup>
- Aid in patient adherence to the prescribed treatment, since the system cannot be removed by the patient.<sup>7,8</sup>

TCC application is also indicated for the treatment and management of acute Charcot foot, to stabilise the structural deformity with or

without plantar ulceration.<sup>1,7</sup> TCC has been shown to create better healing in neuropathic ulcers when compared to a removable cast walker or a half shoe.<sup>6,7</sup>

### Indications for TCC

TCC cannot be applied in isolation and an interdisciplinary team approach is essential.<sup>2,5,9-11</sup> A key indication for TCC is a Wagner wound grade 1 or 2 plantar ulcer, in the presence of insensitivity and acute or sub-acute neuropathic (Charcot) osteoarthropathy.<sup>1</sup> It is important to determine the healability of the diabetic foot ulcer before TCC is applied.<sup>4,5,7,11</sup> Kenshole and MacDonald identified the first five factors that are important in establishing the healability of a diabetic foot ulcer, and the current authors suggest a further two factors<sup>12</sup> [Table 1]. Wound management and patient adherence play an equally important role, as illustrated by newly published international best practice guidelines.<sup>2</sup>

### Contraindications to TCC

Absolute contraindications to TCC are:

- Active or acute deep infection, gangrene (Wagner grades 3-5)<sup>1,2</sup>
- Deep tissue infection<sup>2,14</sup>
- Osteomyelitis<sup>2</sup>
- Exposed tendons, joints and/or bones
- Arterial insufficiency/gangrene.<sup>1,2</sup>

Relative contraindications to TCC are<sup>1</sup>:

- Severe obesity
- Ulcer depth greater than ulcer width
- Fragile skin
- Fluctuating oedema
- Patient unwilling to have cast on limb
- Patient unable to comply with follow-up visits or wearing precautions
- Patient unsafe in mobility while in cast
- Doppler ankle brachial pressure index (ABPI) < 0.4.

### A new TCC system

Several TCC systems and modified TCC systems are available worldwide, and the authors had been using the original Cutimed® Off-Loader and Cutimed Off-Loader Select (both BSN Medical) TCC systems in their practice. However, a need to develop and adapt this system further was identified. South Africa is a country with temperatures ranging from 30°C to above 40°C. This prompted the authors to investigate adaption of the BSN TCC to promote patient compliance. The aim was to provide a washable, light and durable cast, to suit the African conditions and climate. It was also important to address cost-effectiveness of a TCC system, by making it reusable. The use of a washable, reusable cast is not only more hygienic when managing moisture control from sweating, as well as wound exudate, but also allows for better monitoring of wound progress by more frequent removal if required. The need for a system that provided all the necessary items for TCC in one easy-to-use kit was further identified; Table 2 and Figure 1 outline these items, as compiled by authors. The following attributes of the existing BSN TCC system were enhanced to meet the identified needs:

1. Cast weight: lighter-weight fibreglass cast material than original system.
2. Durability: U-splint made from Delta-Lite® Plus (BSN Medical) rigid fibreglass cast tape provides increased stability and strength in ankle and plantar surface areas.
3. Removability: Easy re-application enabled by cutting the Delta-Cast® Soft (BSN Medical) conformable fibreglass cast tape in an s-shape between the two U-splint Delta-Lite Plus fibreglass sheets.
4. Aeration: Delta-Dry® (BSN Medical) stockinette allows for improved vaporisation.
5. Washability and hygiene: the Delta-Dry stockinette allows health practitioners to wash the cast at the time of wound dressing and to re-apply the cast within 20 minutes.
6. Total plantar surface contact: provided by the Delta-Lite Plus rigid fibreglass U-splint and
7. Fanned plantar surface splint
8. Protection and prevention of skin abrasions and additional pressure points: paragon felt used underneath the Delta-Dry stockinette prevents pressure, shear and friction. The felt also provides protection against the skin at cast removal.
9. Open toe box: for easy inspection of toes. Also allowing aeration. Toe box can also be closed at wound re-dressing.



Figure 1: BSN Total Contact Casting materials

Table 1: Factors influencing healability in diabetic foot ulcers, adapted from Kershole and MacDonald.<sup>12</sup>

Description of factors	Criteria
1. Adequate tissue perfusion to the affected site <sup>2,12</sup>	Vascular examination <sup>2,13</sup> Pedal pulses Ankle Brachial Pressure Index (ABPI) Transcutaneous oximetry (TcPO2) Arteriogram Angiogram
2. Presence and management of infection <sup>2,12</sup>	General principles according to international guidelines <sup>2</sup> using the acronym NERDS & STONES <sup>14</sup>
3. Good glycaemic control <sup>2,12</sup>	HbA1C below 7% <sup>12</sup>
4. Regular debridement <sup>2,12</sup>	Removal of devitalised tissue and the promotion of granulation tissue to prepare the wound bed for optimal healing <sup>2,14</sup>
5. Wound management <sup>2,4,5,15</sup>	Application of appropriate wound dressings according to the wound bed preparation guideline <sup>2,11</sup>
6. Adequate pressure redistribution <sup>2,12</sup>	Offloading of plantar pressure areas, <sup>2,3,5,9</sup> particularly effective in offloading forefoot pressures <sup>6</sup>
7. Patient adherence to the treatment programme <sup>2,11</sup>	The patient needs to be an active team member and understand the implications of wearing a TCC. <sup>2,11</sup> Patients also prefer fibreglass casts to plaster casts. <sup>6</sup>

Table 2: BSN Total Contact Cast System product list.

Product name and description	Comments	Quantity
Delta-Net® stockinette 75 mm/3"	First contact layer on skin, double length of lower leg	1
Delta-Dry® stockinette 75 mm/3" or 100 mm/4"	Water resistant stockinette and inner lining of cast	1
Soffban® natural/synthetic 75 mm/3"	Provide cushioning and protection of toes, between and around toes to prevent pressure points	1
Delta-Cast® Soft conformable 75 mm/3"	Soft conformable casting to provide working compression enabling a decrease in oedema and improved blood flow	2
Delta-Lite® Plus fibreglass cast tape 100 mm/4" or Delta-Lite® Plus fibreglass cast tape 75 mm/3"	Use 4" or 3" depending on the size of the foot and limb. To be used as a foot splint and U-splint for stabilisation	1
Co-Plus® 100 mm / crepe 100 mm	Wet bandage to activate polymerisation process and speed up setting time. Aids in moulding and setting of the cast	1
Cast shoe	According to foot size	1
Gloves		2 pairs
Paragon felt	To protect severe bony prominences	As needed

**TCC in action**

The process of fitting the TCC is outlined in *Table 3*; these steps were formed from personal experience as well as the methodology for applying both the 3M and Cutimed Off-Loader and Cutimed Off-Loader select TCC systems. It is advisable to have an assistant onsite to assist in keeping the foot at a 90° angle as demonstrated in step 11 of *Table 3*. It is important that all healthcare professionals receive skills training in applying the system to ensure correct application.

The Delta-Cast Soft conformable fibreglass cast application is essential in providing adequate

venous return, thus decreasing oedema of the lower limb. Shear forces/mechanical stress and blisters formation are prevented by using the paragon felt on all potential pressure points, such as the

malleoli and other prominent areas. Enough space is also created for the toe box area by using Soffban® (BSN Medical) natural or synthetic padding in between the toes and on the edge of the toes.

The total surface contact created by the total contact cast is effective across the whole plantar surface of the foot, irrespective of where the wound is located. The wound location will, therefore, not be a contraindication for the use of the rigid Delta-Lite® Plus (BSN Medical) fibreglass material to create the U-splint and total contact plantar surface area. It is important not to add any additional felt or other thick wound care products in between the casting material and the wound other than a layer of foam dressing or superabsorbent dressing pad.

It is, however, important to avoid any additional felt or over bulking between the casting material and the wound. Depending on the

**Table 3: Applying the BSN Total Contact Casting System.**

Step	Description	Rationale
1	Choose the appropriate wound dressing according to the wound bed preparation guideline and close the wound <sup>2</sup>	Modern moist wound healing principles
2	Prepare all TCC materials according to list, and put gloves and apron on	
3	Delta-Net® stockinette 75 mm/3"	Apply first contact layer directly on skin. Use double length, providing enough stockinette to enable manipulation of the leg and foot
4	Paragon felt	Protect bony prominences with pieces of paragon felt on: <ul style="list-style-type: none"> <li>• Tibial crest</li> <li>• Articulating areas, such as the malleoli</li> <li>• Other bony protrusions.</li> </ul>
5	Soffban® natural/synthetic 75 mm/3"	Apply in between toes and around as a spacer to prevent pressure points in toe box area (needs to be removed after casting)
6	Delta-Dry® stockinette 75mm / 3" or 100mm /4"	Water resistant inner lining of the TCC not to be removed when reapplying new cast
7	Ensure that the patient is relaxed and that the leg to be casted is in the right position. The leg should be supported underneath the knee with a pillow or leg raise to prevent muscle contraction	
8	Delta-Cast® Soft conformable 75 mm/3"	<ul style="list-style-type: none"> <li>• Apply Delta-Cast® soft in a lateral-to-medial direction, with little to no tension (do not wet)</li> <li>• Start 2 cm below the caput fibula to prevent damage to the perineal nerve</li> <li>• Spiral down to the heel with 1/3 overlap</li> <li>• Strap to ensure that the foot is locked in a 90° angle ('heel lock') on the lateral side of the heel and then go straight up to the fifth toe and wind over on dorsum side</li> <li>• Second heel lock on medial side circle around dorsum of foot again (heel needs to be fully covered with at least two layers).</li> </ul>
9	Delta-Lite® Plus fibreglass cast tape 100 mm/4" or Delta-lite® Plus fibreglass cast tape 75 mm/3"	Use this for preparation of U-splint and foot splint at plantar base. <ul style="list-style-type: none"> <li>• Measure mid-calf and use three layers of the Delta-Lite® and prepare the U-splint</li> <li>• Plantar base: start on medial side and fan out over the plantar area to the lateral side (ensure minimum three layers on sides with total of six layers in the middle of the foot). Remember to widen the distal end to guarantee sufficient support for toes.</li> </ul> Do not wet the splints; put aside until needed
10	Delta-lite® Plus fibreglass cast tape 75 mm/3" previously prepared splints	Apply the foot splint under the foot with the U-splint on top of this. (Assistant can hold this in place while you prepare the second soft cast)
11	Delta-Cast® Soft conformable 75 mm/3"	Apply Delta-Cast® soft in lateral-to-medial direction, with little to no tension. Same as first layer (see step 10)
12	Make sure the foot is still in the correct position, dorsi-flexion and neutral position	
13	DCo-Plus® 100 mm/crepe 100 mm	Apply the wet bandage, dipped in water, over the cast to speed up the setting process
14	Make sure the foot is still in the correct position, dorsi-flexion and neutral position	
15	Co-Plus® 100 mm/crepe 100 mm	Remove the wet bandage and let the patient's leg rest
16	Toe box	Start cutting around the toes to provide sufficient space and remove the soffban
17	Patient can start weight-bearing after 20 minutes. Apply correct size post-operative shoe to protect the cast	
18	Patient education is essential	

exudate of the wound, a patient can even be seen within 24 hours to monitor the wound bed. The easy removal and re-application of the cast makes this possible without wasting the primary TCC. The frequency of dressing changes and cast removal is thus up to the discretion of the healthcare professional.

Once the TCC is *in situ*, the patient can start to weight bear within 20 minutes, wearing the rocker bottom cast shoe. Patients are given instructions on TCC use [Box 1]. Common problems arising from the use of TCC are patient compliance in follow-up visits, and, occasionally, pressure, shear and friction injuries.

**Box 1: Patient instructions for Total Contact Casting use.**

- Always wear your rocker bottom cast shoe when walking
- You may use a cane or crutch to assist you with keeping your balance
- Avoid using flights of stairs or walking for long distances while wearing the cast
- Do not submerge the cast in water
- Do not try to remove the cast yourself but consult your health practitioner for removal
- Please contact your health professional immediately in case of the following
  - Swelling of the leg or foot
  - Increased pain in any area of the cast
  - Wound exudate leaking from the cast
  - Foul odour present from the cast or wound site
  - Any break or tear in the cast material.

**Clinical experience**

On introducing the adapted TCC system into the authors' services, good results were seen, including the treatment of a patient with severe peripheral neuropathy and a history of foot trauma due to shear and friction. This patient drove a delivery truck for 12-hour periods, resulting in blistering with subsequent bleeding and tissue breakdown. This resulted in a neuropathic diabetic foot ulcer (DFU) of the second and third metatarsal heads [Figure 2a]. The new TCC system was applied, as described in Table 3, and after 12 days, the wound had healed rapidly following TCC use, with good epithelialisation and only a small area of granulation tissue [Figure 2b].

In another complex case, a patient with a foot deformity secondary to Charcot presented with ulceration of his foot. Two years prior to presentation, the patient had developed a blood blister on his foot after he was supplied with faulty innersoles, and he was then referred to an orthopaedic surgeon. The surgeon stabilised the Charcot foot in theatre, however, 6 months later the patient developed a new blood blister, which was then surgically debrided. The foot continued to ulcerate after this, with subsequent incidences of bleeding due to pressure. Wound care was initiated together with the BSN TCC, and complete closure, as well as stabilisation of the Charcot mid-foot defect, was achieved within 8 days [Figure 3].

**Discussion**

The International Diabetes Federation recommends that a specialist footcare team must include doctors with a special interest in diabetes, individuals with educational skills and those with formal training in foot care (usually diabetes podiatrists and trained nurses). To ensure comprehensive care, this team should be enhanced by



**Figure 2:** Neuropathic diabetic foot ulcer, second and third metatarsal head. a) Day 0 of treatment; b) Day 12 of treatment with total contact casting.



**Figure 3:** Mid-foot diabetic foot ulcer in Charcot foot; a) and b) Day 0 of treatment; c) Day 5 of treatment with total contact casting; d) Day 8 of treatment with total contact casting showing structural stabilisation of Charcot foot.

vascular surgeons, orthopaedic surgeons, infection specialists, orthotists, social workers and psychologists.<sup>2</sup> In South Africa, it is standard practice that wound care specialist nurses and podiatrists work together with a vascular surgeon in a multidisciplinary team in the treatment of DFUs. However, use of TCC in South Africa has been limited to date.

## Evaluation

At the two centres involved in the development of the new TCC system, staff have a combined experience with various methods of TCC of more than 15 years. Since the introduction of the new TCC kit, several practical skill-based workshops have been provided by the authors across South Africa. These workshops also included a pre-workshop questionnaire evaluating the participants' knowledge base with regards to TCC use. Most participants listed the following reasons for not applying TCC in their practice:

- The need for more skills
- Uncertainty regarding its application
- Fear of failure and causing harm.

Most people attended the workshops to improve their skills. Once they had done the practical training, participants were followed up via email and telephone, to explore their practice after completing the workshop. Several practitioners agreed that the new adapted system was easier to apply and that adherence to the treatment programme had improved. Feedback from their patients were that mobility had improved. Positive aspects of the system highlighted in this feedback included:

- The helpful step-by-step application guide
- Easy-to-use casting material
- Patients healing faster
- Improved patient mobility and quality of life
- Cost-effectiveness

Negative feedback related to:

- Continuous practical application required to maintain skill level
- Difficulty in keeping the foot in the correct 90° angle to prevent creasing and added shear and friction.

The application of the TCC system is making a difference by:

- Reducing plantar pressure
- Reducing lower limb oedema
- Reducing treatment time (fast application)
- Reducing overall wound healing time
- Reducing overall wound care costs
- Ensuring patient adherence
- Improving patient mobility
- Improving patient's quality of life
- Preventing amputation.

It is recommended that more skills training workshops are needed to guide healthcare professionals and change perceptions in incorporating TCC as the gold standard in all practices working with patients with DFUs.

## Conclusion

DFUs are complex, chronic wounds, which have a major impact on morbidity, mortality and quality of life, as well as socio-economic circumstances. In South Africa, the authors are seeing more DFUs on a daily basis. Around 25% of people with diabetes will develop a DFU during their lifetime.<sup>2,7</sup> Every 20 seconds, a lower limb is amputated due to complications of diabetes,<sup>15</sup> however, up to 85% of amputations can be avoided when an effective care plan is adopted.<sup>1,2,11,12,15</sup> It is clear that TCC is the gold standard offloading method worldwide. This article introduces and describes the TCC system for the South African environment, and illustrates its effectiveness and ease of use.

## Conflict of interest:

All product material was provided by BSN Medical

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