Complications of Total Contact Casting

The benefits of using TCC still far outweigh any risks.

BY ROBERT GREENHAGEN, DPM

Dr. Milroy Paul and Joseph Kahn first utilized casting for trophic ulceration secondary to Hansen’s disease in Ceylon, India. Khan published his technique and case series on TCC in 1939. Dr. Paul Brand was the first to adopt the TCC, which he learned in India, for the treatment of diabetic foot ulcerations. Brand modified the technique and reduced the amount of padding to allow the cast to conform to the leg. This reduced the shearing forces that occurred as the padding compressed and edema decreased, therefore reducing the risk of developing new ulcerations.

Since that time numerous studies have demonstrated the effectiveness of TCC. Healing rates of plantar ulceration have been reported to range from 73% to 100%. Many experts consider the TCC the gold standard for off-loading the plantar surface of the foot. Lavery, et al. demonstrated a reduction of peak plantar pressure at the ulcer site ranging from 81% to 92% compared to canvas sneakers. The exact mechanism by which TCC unloads the foot is not entirely clear. Two mechanisms have been proposed as to how TCC off-loads the foot: load redistribution and load sharing.

**Load Redistribution**

The theory of load redistribution was introduced by Brand, who postulated that the decrease in pressure is due to an increase in the weight-bearing surface area. Since pressure is defined as force divided by area, increasing the surface area over which the plantar force is applied will in turn reduce the plantar pressure. Shaw, et al. found that TCC transferred load from the forefoot to the rearfoot. Leibner and colleagues, however, found that the forefoot continued to bear the majority of plantar foot pressure (forefoot = 36%, midfoot = 13%, rearfoot 15%), despite a significant decrease in the overall plantar load. These finding are similar to those of other authors, and the load redistribution theory appears to play a lesser role than previously thought.

**Load Sharing**

The second theory, known as load sharing, was described by Shaw, et al, in 1997. They postulated that the decrease in plantar pressure is due to the proximal portion of the TCC bearing much of the load. To support this theory, they demonstrated that the proximal cast wall or shank bore 30% of the load during ambulation. Leibner, et al. reported similar findings and demonstrated that the shank of the cast bore 36% of the weight-bearing load. Once the shank was removed, the plantar load increased to the entire foot (forefoot 36% to 56%, midfoot 13% to 17% and rearfoot 15% to 28%). These findings support that load sharing, or the transfer of force to the tibia, is more important to off-loading ulcerations than load redistribution.

**Other Factors**

TCCs are effective for a number of reasons in addition to their ability to mitigate pressure. First, casting helps to reduce and/or control edema. Many experts consider the TCC the gold standard for off-loading the plantar surface of the foot. Lavery, et al. demonstrated a reduction of peak plantar pressure at the ulcer site ranging from 81% to 92% compared to canvas sneakers. The exact mechanism by which TCC unloads the foot is not entirely clear. TCCs are effective for a number of reasons in addition to their ability to mitigate pressure. Healing rates of plantar ulceration have been reported to range from 73% to 100%. Many experts consider the TCC the gold standard for off-loading the plantar surface of the foot. Lavery, et al. demonstrated a reduction of peak plantar pressure at the ulcer site ranging from 81% to 92% compared to canvas sneakers. The exact mechanism by which TCC unloads the foot is not entirely clear.

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shown that removable cast walkers (RCW) are as effective as TCC for off-loading the plantar neuropathic ulcer, but clinically, the TCC and RCW are not equal.14-16

The TCC heals a higher proportion of wounds in a shorter period of time compared to the RCW.17 This is due to the difficulty of removing the cast, so the patient has little choice other than to adhere to the regimen prescribed by the clinician. Armstrong, et al. reported that patients treated with a removable device wore the device for a total of 28% of their daily activity with the most compliant population not exceeding 60%.18 Finally, it seems that the TCC significantly decreases the amount of ambulation and activity of the patient. This reduces the number of cycles of repetitive stress on the open ulceration.17

TCC for Non-Forefoot Ulcerations
Some question exists on the effectiveness of TCC for the treatment of “non-forefoot” ulceration. As stated previously, TCC does not transfer the plantar force from the forefoot to rearfoot as much as previously was thought.9-11 Armstrong and Stacpoole-Shea found that TCC is significantly more effective at off-loading heel pressure than any other off-loading devices.19 Walker and Helm demonstrated that TCC is effective in both forefoot and non-forefoot ulcerations, though forefoot ulcerations healed significantly faster than ulcers on other parts of the foot.20 Therefore, TCC should be considered for off-loading all plantar ulcerations.

Iatrogenic Complications
A major area of concern is the risk of iatrogenic complications with TCC therapy (Table 1), though the vast majority of these complications are minor. Most of the reported major complications are due to previously undiagnosed osteomyelitis and patient noncompliance.21-23 The most common minor complications are dermal abrasions.5, 21-27 Wukich and Motko found that 93% (13/14) of their complications were minor pressure ulcers and did not require a change in the treatment protocol.

The locations of these iatrogenic wounds were as follows: hindfoot—four, medial aspect of the navicular—four, tibial crest—three, and second toe—two. The authors found that the medial aspect of the navicular was a high-risk area for pressure-related complications in patients with Charcot neuroarthropathy who had rocker bottom deformity. This is consistent with the findings of Guyton and colleagues.27

The highest risk for complication was Charcot neuroarthropathy, which was associated with 1.5 fold risk of increased complication.
portant factor for decreasing the risk of iatrogenic complications is frequent cast changing.26,27

Guyton, et al. analyzed the iatrogenic complications associated with TCC.27 They reported a complication rate of 5.5% per cast.27 The authors then evaluated the various risk factors with an increased risk of iatrogenic complications. The use of a cast after deformity-correcting surgery (OR = 0.44), the overall presence of neuropathy (OR = 0.69), age (OR = 1.03) and time between cast changes (OR = 0.99) were not found to increase the risk of complications.27 The strict cast changing protocol and adherence to proper techniques likely reduced the risk of TCC complications.27 While biomechanical and thermometric evaluation have shown that the contralateral limb does not seem to have an increased risk of ulceration, this is always an area of potential concern due to a change in the patient’s customary gait pattern.26,28,29

TAL Complications
A separate risk of iatrogenic calcaneal ulceration exists if an Achilles tendon lengthening (TAL) has been performed in combination with TCC. Mueller, et al. found that TAL decreases the risk of ulcer recurrence by 75% at seven months and 52% at two years.30 The decrease in recurrence is due to the decrease in plantar flexor power caused by a transient weakness of the triceps surae.31 While a TAL offers a decrease in recurrence rate, over-lengthening of the heel cord may result in a calcaneal gait and increased pressure on the plantar aspect of the heel (Figure 1).30 Nishimoto and colleagues estimated that the risk of overloading the heel is 2 to 10% in a diabetic population undergoing a TAL.32 Care must be taken to avoid over-lengthening in any patient with a

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**TABLE 1**

Reported Complication Rates of Total Contact Casting in the Literature

<table>
<thead>
<tr>
<th></th>
<th># of Patients</th>
<th># of Casts</th>
<th>Healing Rate</th>
<th>Complication Rate per Patient</th>
<th>Complication Rate per Cast</th>
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<td>13</td>
<td>*</td>
<td>85</td>
<td>15</td>
<td>*</td>
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<tr>
<td>Boulton et al4</td>
<td>7</td>
<td>*</td>
<td>100</td>
<td>43</td>
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<td>Guyton27</td>
<td>70</td>
<td>398</td>
<td>*</td>
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<td>73</td>
<td>14</td>
<td>*</td>
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<td>*</td>
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<td>27</td>
<td>*</td>
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<tr>
<td>Wukich and Motko26</td>
<td>13</td>
<td>82</td>
<td>83</td>
<td>*</td>
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</tbody>
</table>

* = not reported
neuropathic heel. Alternatively, one can consider performing a gastrocnemius recession which has been postulated to reduce the risk of over-lengthening of the Achilles while still off-loading the foot.

Summary
While the medical evidence supports the use of TCC in the treatment of plantar ulcers, this treatment modality is grossly under-utilized and under-appreciated. The multi-billion dollar industry that has spawned the advanced wound care industry has not produced any treatment regimen that compares to the total contact cast. As the medical field continues to evolve towards evidence-based medicine and possibly pay for performance, clinicians must re-evaluate their present treatment protocols. The high efficacy of the total contact cast with low risk of major complications will continue to be the gold standard for the treatment of neuropathic pedal ulcerations.

References
27 Guyton GP. An analysis of iatrogenic complications from the total contact cast. Foot Ankle Int 26: 903-7, 2005.