

Managing sweat without compromising liner traction

1- The starting point

A sweat-management layer only works if the prosthetic liner still has enough traction to stay secure. So we tested liner grip first.

2 - Define minimal traction resistance benchmark

Published walking loads gave us a reference range of 30-45 N (3kg - 4.5 kg). For design testing, we selected 90 N (9kg) as a high intensity benchmark.

30-45 N^{1,2,3}

typical tensile loads reported during walking benchmark.

90 N^{1,2,3}

selected benchmark for higher intensity activity

3 - Find how much direct skin-to-liner contact is enough

We then tested the liner directly on a silicone test leg. With 10 cm of direct distal contact, displacement occurred at approximately 300 N (30kg) - more than 3x the 90 N (9kg) benchmark.

~300 N (30 kg)

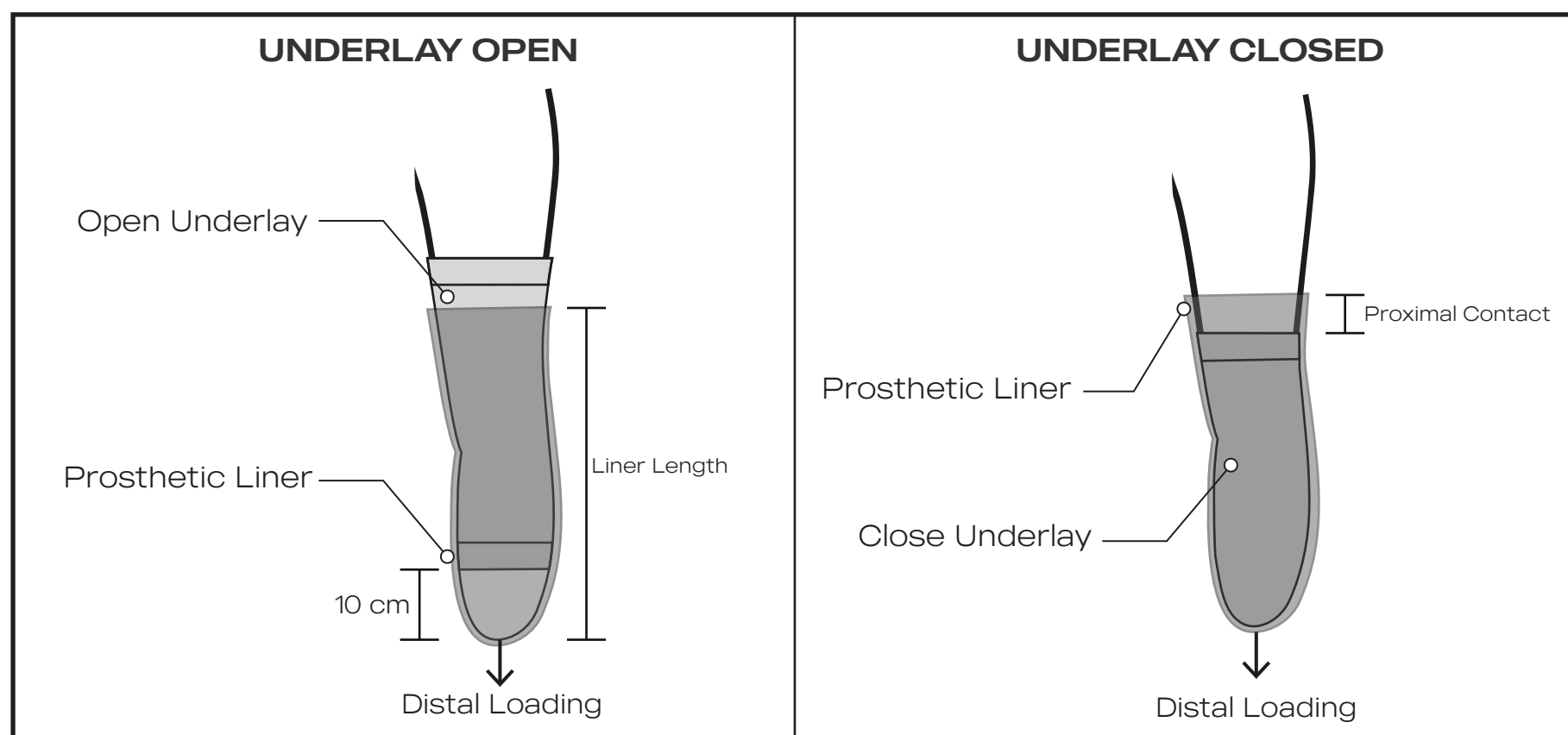
With 10 cm contact

DESIGN DECISION

Keep a 10 cm distal direct-contact zone with the Liner for the **Open** Underlay

4 - Test both Underlay concepts

Next, we tested the actual product configurations to confirm that both concepts stayed above the 90 N benchmark under the evaluated laboratory conditions.



5 - Traction test results

Underlay Open	Underlay Close
Leaving 10 cm uncovered at distal end . Tested configurations remained above 90 N; at 25 cm liner length, resistance was ~333 N (33 kg) and increased to ~490.5 N (49kg) at 35 cm .	Covers the full residual limb. Traction was tested using proximal skin-to-liner contact: 618 N (62 kg) with 5 cm of contact and 706 N (70kg) with 10 cm .
TESTED SAFETY FACTORS: approximately 3.7X to 7.8X the 90 N benchmark	

Once traction was validated, we addressed heat, humidity, and comfort.

6 - Ask users what they actually feel

Fifteen transtibial and transfemoral prosthetic users (n=15) tested the Underlay during walking, cycling, hockey and daily activities.

51%

reduction in perceived humidity

38%

reduction in perceived heat

8/10

average comfort score

7 - Measure the humidity level objectively

Miniature humidity sensors beneath the prosthetic liner compared the liner alone with the liner + Underlay during rest and walking. Humidity rose in both conditions, but remained lower with the Underlay during resting and walking phase.

LINER ONLY	LINER + UNDERLAY
87.7% Maximum Relative humidity	74.8% Maximum Relative humidity
AVERAGE RELATIVE HUMIDITY REDUCTION OF 15.2%	

What the evidence shows

- 1

The Open Underlay's 10 cm distal contact zone came directly from traction testing.
- 2

Users reported less humidity and heat, with an average comfort score of 8/10.
- 3

Both Open and Closed configurations exceeded the selected 90 N benchmark.
- 4

Sensor testing supported the user feedback, with slower humidity accumulation and up to 17.3% lower RH.

Testing note: Results reflect the evaluated laboratory and user-test conditions. Individual results may vary based on anatomy, liner type, socket configuration, activity level, and product fit. Detailed test methodology and results are available upon request.