Advanced lightweight cooling - garment technology: functional improvements in thermosensitive patients with multiple sclerosis

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Background

Heat-sensitivity, resulting in clinical deterioration, is a phenomenon described in up to 80% of patients with multiple sclerosis. Lowering body temperature can improve clinical symptoms.
Hence, there is a high interest in an efficacious, practical, lightweight and cost-saving cooling system.

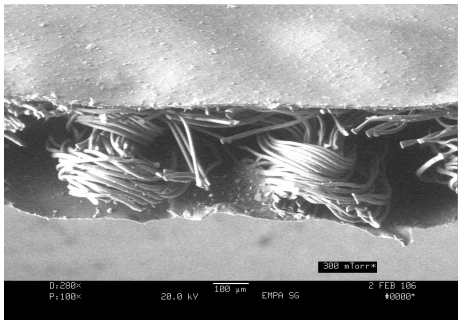
Summary & Conclusion

In order to study the effectiveness of an advanced lightweight cooling-garment technology based on aquatic evaporation, a single blinded balanced crossover study was performed on twenty patients with multiple sclerosis. The results, using a tight-cuff cooling-garment prototype for peripheral cooling, suggest improvement of a walking velocity, leg-strength, fine-motor hand skills and subjective benefits. Technical information was gained about the cooling activity, the practicability and handling of the device. These encouraging findings will promote further adaptations of the prototype to increase its cooling properties and ameliorate the practicability of the cooling garment.

Patients & Methods

Single blinded, balanced crossover study on twenty heat sensitive MS Patients with a EDSS >=6.5. Outcome measurements: Skin temperature and ECG for measuring the heart rate variability (HRV) were continuously logged. Tympanic temperature was measured at the beginning and end of examination sessions. A neurological examination consisting of MS Functional Composite (MSFC), modified Ashworth scale, body sway by a static force platform and muscle strength was performed, followed by a structured interview about wearing comfort, subjective perception of cooling effect on bodily functions (general well-being, pain, voiding, sweating) with a scoring system from 1 to 10.

➔ ***Figure*** *Thigh-cuff cooling garments. The arrow shows the filling tube for water to activate cooling system.*



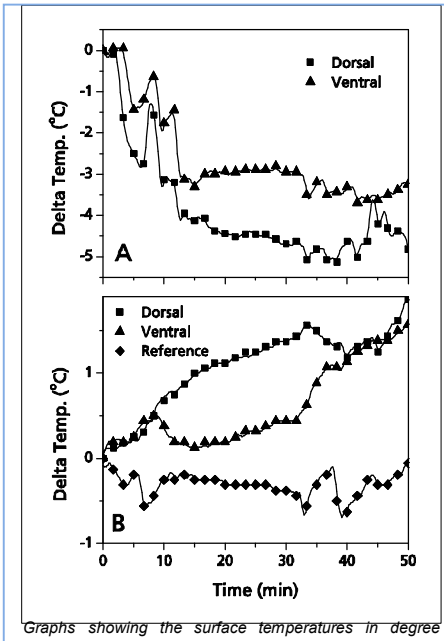
↑ ***Figure*** *Scanning Electron Microscope (SEM) cross section of the cooling pad. Operational principle of cooling is a textile-based laminate of two waterproof, vapour-permeable polyester membranes ➢, which coat a hydrophilic fabric ■. By adding water (40 ml), evaporation leads to lowering of peripheral temperature.*

Results

Mean age within the study group was 48.7 yrs (range 27-66), median EDSS 5.5 (range 1.5-6.5). The temperature reduction of the skin was 4.32±1.21°C (range 1.81-6.57). There was no alteration in tympanic temperature in either group. The activated cooling garment significantly improved the total MSFC (p=0.017), timed 25-feet walk (p=0.035), 9HPT (p=0.012) and strength in lower limbs (p=0.004). In the structured interview we found a tendency in improvement of general well-being. While cooling, preliminary data including six patients (mean age 47.3 yrs) show a mean HRV of RMSSD- and SDNN values of 80.4 msec and 91.7 msec resp. During sham control condition there was a considerably decreased HRV with mean RMSSD- and SDNN-value of 49.5 msec and 76 msec resp. HRV-values of the MS patients during cooled condition show similar results compared with six healthy subjects (mean age 41.7 yrs).

Outcome measure		Active cooling		Sham control		P value
Tympanic temp. change (°C, SD)		-0.092	(0.25)	-0.047	(0.22)	0.126
MSFC (z-Score, SD)		0.952	(0.88)	0.723	(1.11)	0.017
T25FW (s mean, SD)		14.2	(10.8)	18.0	(17.3)	0.035
9HPT (s mean left/right), (median, IQR)		29.5	(9.6)	34.3	(17.1)	0.012
PASAT3 (no. correct mean, SD)		40.4	(16.5)	39.4	(15.9)	0.747
Postural sway, 30 s* (cm/s, SD) (Mean displacement velocity)	☐ eyes open	2.24	(0.97)	2.53	(1.05)	0.65
	☐ eyes closed	3.98	(1.72)	4.39	(2.15)	0.55
Spasticity (Modified Ashworth Scale) mean left/right (SD)	☐ Ellbow	0.48	(0.47)	0.68	(0.61)	0.021
	☐ Knee	1.08	(1.0)	1.08	(0.9)	0.835
Isometric muscle strength, (mean left/right, kg, median, IQR)	☐ Knee extension	24.6	(17.3, 32.6)	22.7	(14.5, 33.4)	0.004
	☐ Foot dorsal flexion	12.1	(10.2, 18.4)	11.7	(7.8, 16.1)	0.037
	☐ Grip strength	26.5	(19.3, 33.9)	24.2	(18.1,34.6)	0.563

MSFC = MS Functional Composite; T25FW = Timed 25-Foot Walk; 9HPT = Nine-Hole Peg Test; PASAT3 = Paced Auditory Serial Addition Test with a 3-second interstimulus interval; RMSSD= Root Mean Square Successive Difference; SDNN= Standard Deviation of all Normal RR Intervals. * 10 s of the recording have been omitted systematically to avoid disturbance from delayed stabilisation of the recording equipment after the person stepped onto the force plate.



Graphs showing the surface temperatures in degree Celsius (°C) versus time during a standard assessment of a representative subject. (A) Activated cooling system expressed as difference from the reference probe, Delta T [Celsius] 0° means skin temperature at the beginning of the assessment. (B) non-operating cooling system

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