PHYSIATRY '23

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Measuring the Efficacy of Percutaneous Cryoneurolysis in the Management of Patients With Plateaued or Refractory Shoulder Spasticity

Paul Winston,[1,2] Mahdis Hashemi,[1,2] Eve Boissonnault,[2,3] Daniel Vincent,[1] Fraser MacRae,[2,4] Jia Song,[5] Meng-Hsuan Sung,[5] Sandy Shi[5]

[1]The University of British Columbia, Vancouver, BC, Canada; [2]Vancouver Island Health Authority, Victoria, BC, Canada; [3]University of Montreal Health Center, Montreal, QC, Canada; [4]Western University, London, ON, Canada; [5]Pacira BioSciences, Inc., Parsippany, NJ, USA

Disclosures

Paul Winston declares that he has had educational grants and has acted on ad boards and as a consultant for Pacira BioSciences, Inc.; AbbVie; Merz Therapeutics; and Ipsen

Mahdis Hashemi declares that she has no conflicts

Eve Boissonnault declares that she has had educational grants and has acted on ad boards and as a consultant for Pacira BioSciences, Inc.; AbbVie; Merz Therapeutics; and Ipsen

Daniel Vincent declares that he has acted as a consultant for Pacira BioSciences, Inc.

Fraser MacRae declares that he has no conflicts of interest

Jia Song, **Meng-Hsuan Sung**, and **Sandy Shi** are employees of Pacira BioSciences, Inc.

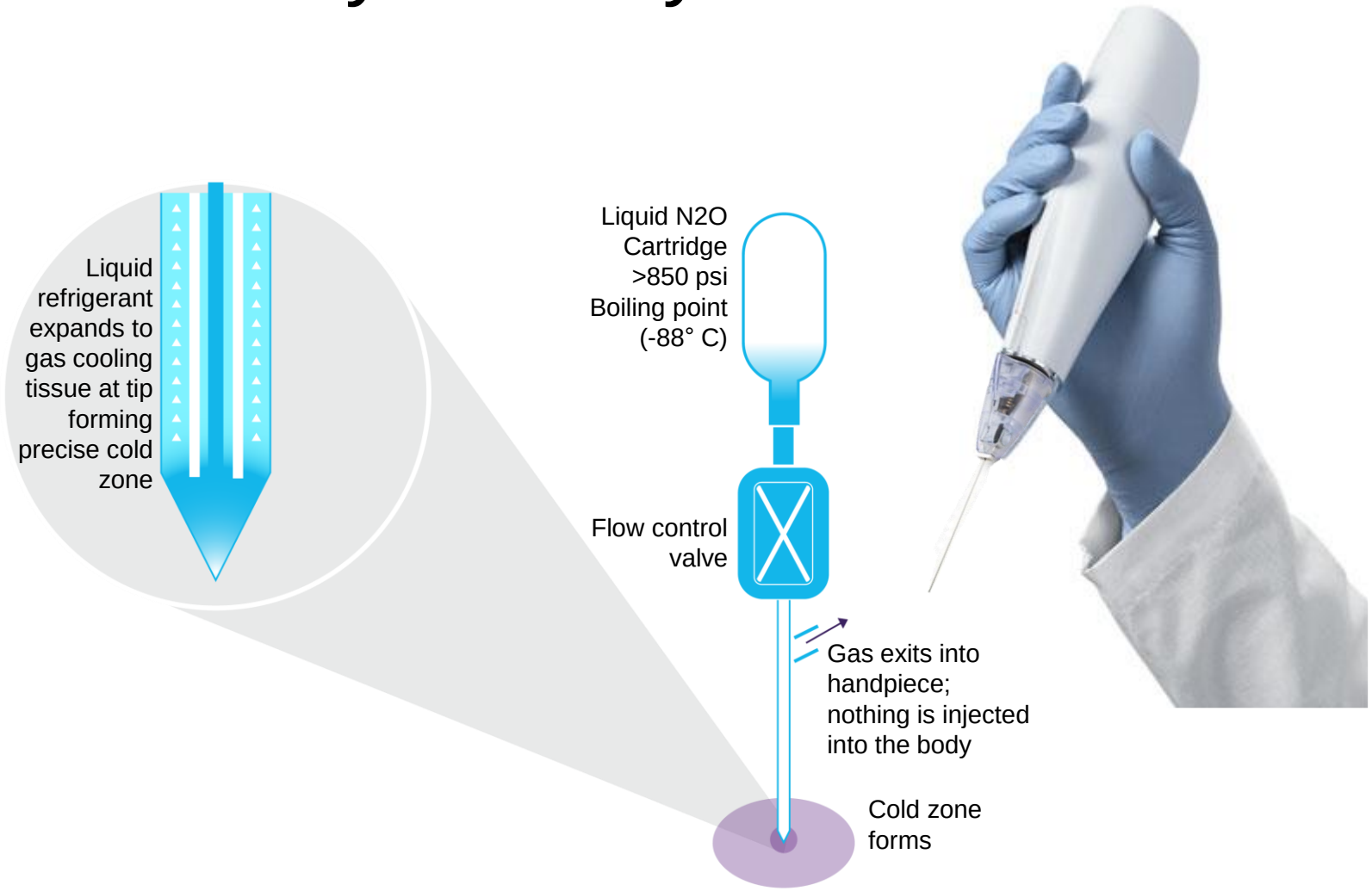
Introduction

- Conventional treatments for spasticity are costly and have limited duration for some patients[1,2]
  - In the United States, the use of botulinum toxin in the shoulder girdle is considered off label
  - There is a need for novel treatment options to improve patient outcomes
- The muscles most commonly targeted for management of shoulder spasticity include the pectoralis major and minor, subscapularis, and latissimus dorsi[3,4]
  - The suprascapular nerve provides nearly 70% of sensory input to the shoulder[3]
- Percutaneous cryoneurolysis is a minimally invasive technique that has been used to reduce pain associated with knee osteoarthritis,[5] total knee arthroplasty surgery,[6] and neuralgia[7]
  - A previous case series suggested that cryoneurolysis may be a promising treatment for spasticity, but additional data are needed[8]

1. Orsnes GB et al. *Acta Neurol Scand*. 2000;101(4):244-248; 2. Ward A et al. *J Rehabil Med*. 2005;37:252-257. 3. Fitterer JW et al. *Front Neurol*. 2021;12:668370; 4. Simpson DM et al. *PM&R*. 2017;9(2017):136-148; 5. Radnovich R et al. *Osteoarthr Cartil*. 2017;25(2017):1247-1256; 6. Urban JA et al. *Arthroplast Today*. 2021;10(2021):87-92; 7. Kim CH et al. *Pain Physician*. 2015;E363-E368; 8. Winston P et al. *Arch Rehabil Res Clin Transl*. 2019;1:100030.

Overview of Cryoneurolysis

- Probe cooled to between -60°C and -88°C near targeted nerve[1-3]
  - Cooling causes secondary axonotmesis and Wallerian degeneration, allowing for axonal regrowth[4]
- Effects can be prolonged for several months in some cases[5]

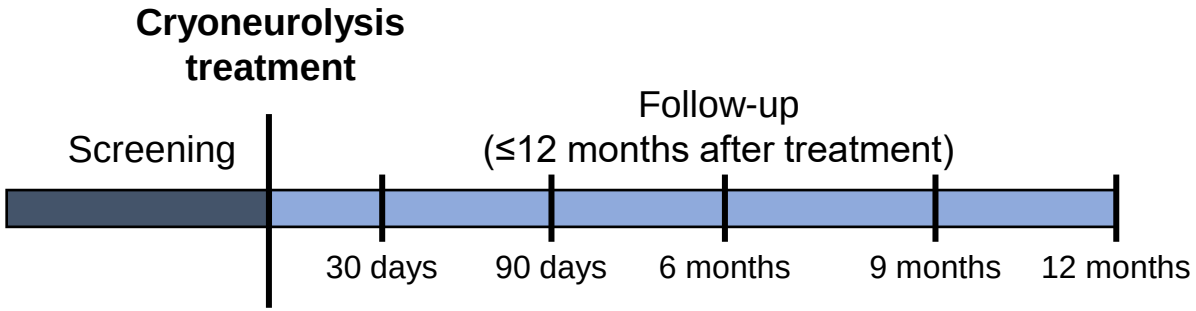


Drawing not to scale. For illustrative purposes only.

1. Rubenstein J et al. *Am J Phys Med Rehabil*. 2021;100(5):e65; 2. Winston P et al. *Arch Rehabil Res Clin Transl*. 2019;1:100030; 3. Shaffer JP et al. *Orthop J Sports Med*. 2022;10(5):23259671221096095; 4. Guirguis M et al. Cryotherapy. *Deer's Treatment of Pain*. 2019; 5. Radnovich R et al. *Osteoarthr Cartil*. 2017;25(2017):1247-1256.

Methods: Study Design

- This repeated-measures pilot study (NCT04670783) included participants who underwent cryoneurolysis to the lateral and/or medial pectoral nerves
  - In some cases, neurolysis was applied to the suprascapular nerve to manage pain
- Outcomes were measured at baseline and at follow-up at 30-day, 90-day, 6-month, 9-month, and 12-month intervals
- All participants have at least 6 months of follow-up



Outcome	Measure*
Mean active ROM	ROM during abduction, external rotation, and flexion
MAS score	Muscle tone during abduction, external rotation, and flexion
V1 score	Maximal passive stretch during abduction, external rotation, and flexion
V3 score	Fast catch during abduction, external rotation, and flexion
GAS	Patient satisfaction

Objective: Evaluate the outcomes of cryoneurolysis in patients with spastic shoulder who had plateaued in prior treatments, including botulinum toxin therapy

*Each was measured at 30 days, 90 days, 6 months, 9 months, and 12 months.
GAS, goal attainment scale; MAS, modified Ashworth scale; ROM, range of motion; V1, maximal passive stretch; V3, fast catch.

Methods: Eligibility Criteria

Inclusion criteria	Exclusion criteria
• Adults with upper extremity spasticity causing functional impairment, who have plateaued in outcomes, in which the clinical examination suggested further interventions can be trialed	• Being unable to attend the treatment schedule
• Upon clinical examination, V1 and V3 measures on upper extremity demonstrated that further range may be possible (versus management of contracture)	• Prior neurolytic procedure to the nerve such as phenol or cryoneurolysis in the past 2 years
• Reducible spasticity (versus contracture) in a diagnostic nerve block to determine whether cryoneurolysis would be beneficial	
• Participants were offered a cryoneurolytic procedure and consented to undergo the procedure	

V1, maximal passive stretch; V3, fast catch.

Results: Baseline Characteristics

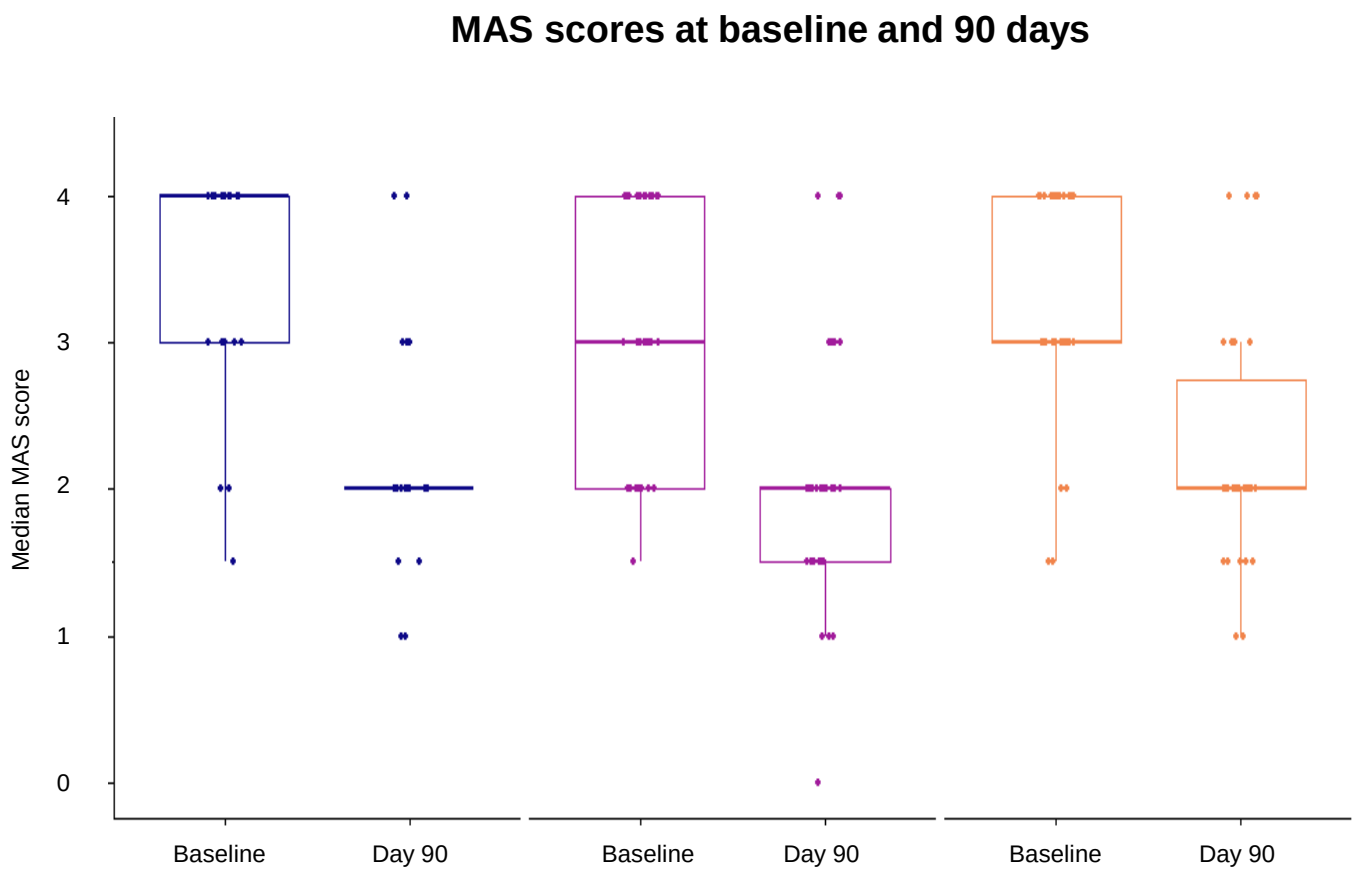
- 42 of 47 participants underwent cryoneurolysis of the shoulder
- At baseline, participants had reduced median active ROM and high median scores on MAS during abduction, external rotation, and flexion, suggesting severe spasticity with possible musculotendinous contracture

Outcome	Baseline n=42
Median active ROM (IQR)	
Abduction	50.0 (48.8, 70.0)
External rotation	5.0 (-13.8, 20.0)
Flexion	55.0 (37.5, 70.0)
Median MAS score (IQR)	
Abduction	4.0 (3.0, 4.0)
External rotation	3.0 (2.0, 4.0)
Flexion	3.5 (3.0, 4.0)
V1 score (IQR)	
Abduction	95.0 (82.5, 100.0)
External rotation	25.0 (10.0, 40.0)
Flexion	92.5 (85.0, 103.8)
V3 score (IQR)	
Abduction	75.0 (70.0, 85.0)
External rotation	0.00 (-6.3, 6.3)
Flexion	70.0 (66.3, 85.0)

IQR, interquartile range; MAS, modified Ashworth scale; ROM, range of motion; V1, maximal passive stretch; V3, fast catch.

Results: 90-Day Changes From Baseline

- 42 patients completed the 90-day follow-up at the time of this analysis
- Significant improvements were observed in MAS scores for abduction, external rotation, and flexion (*P*<0.001)



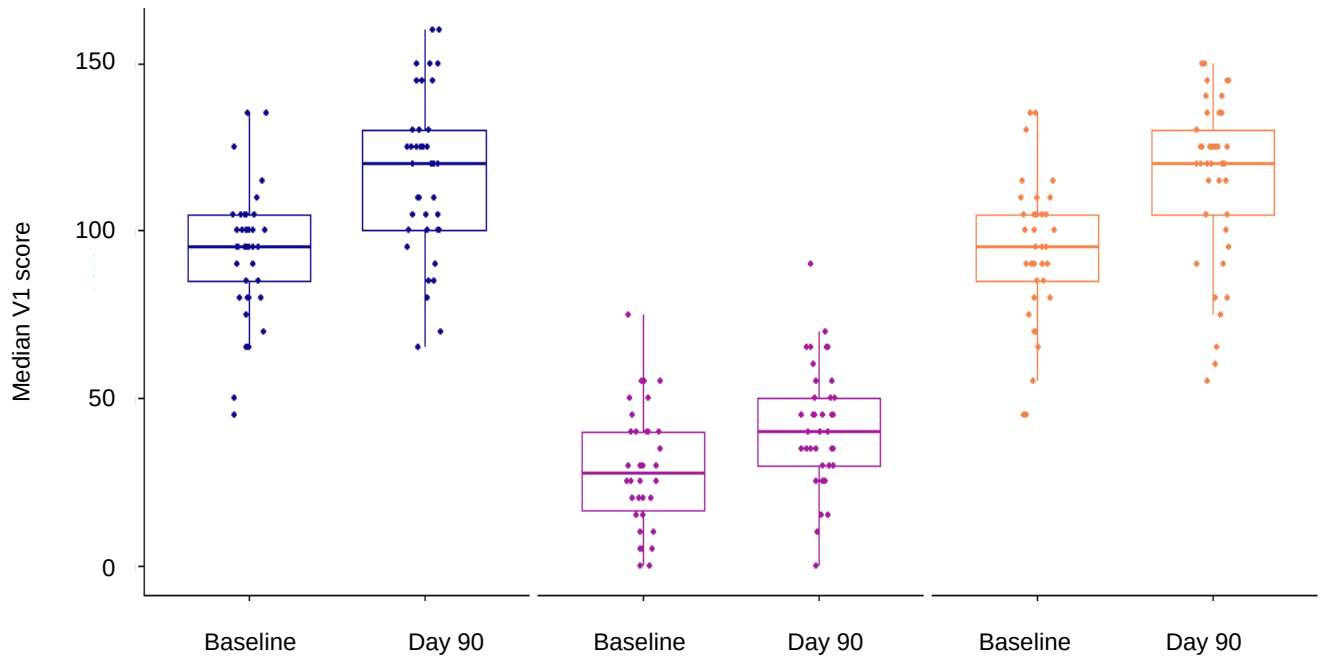
Outcome	90-day change n=40	*P* value
Median MAS scores (IQR)		
Abduction	-1.0 (-2.0, -1.0)	<0.001
External rotation	-1.0 (-2.0, -0.5)	<0.001
Flexion	-1.0 (-1.5, -0.75)	<0.001

IQR, interquartile range; MAS, modified Ashworth scale; ROM, range of motion.

Results: 90-Day Changes From Baseline (cont)

- Significant improvements were observed in V1 scores for abduction, external rotation, and flexion ($P<0.0001$)*
  - These changes resulted in a 3-dimensional change in ROM
  - V3 was not reliably measurable after baseline
- There was a numerical increase in mean improvement per patient in GAS scores at 90 days (10.5 points)

V1 scores at baseline and 90 days

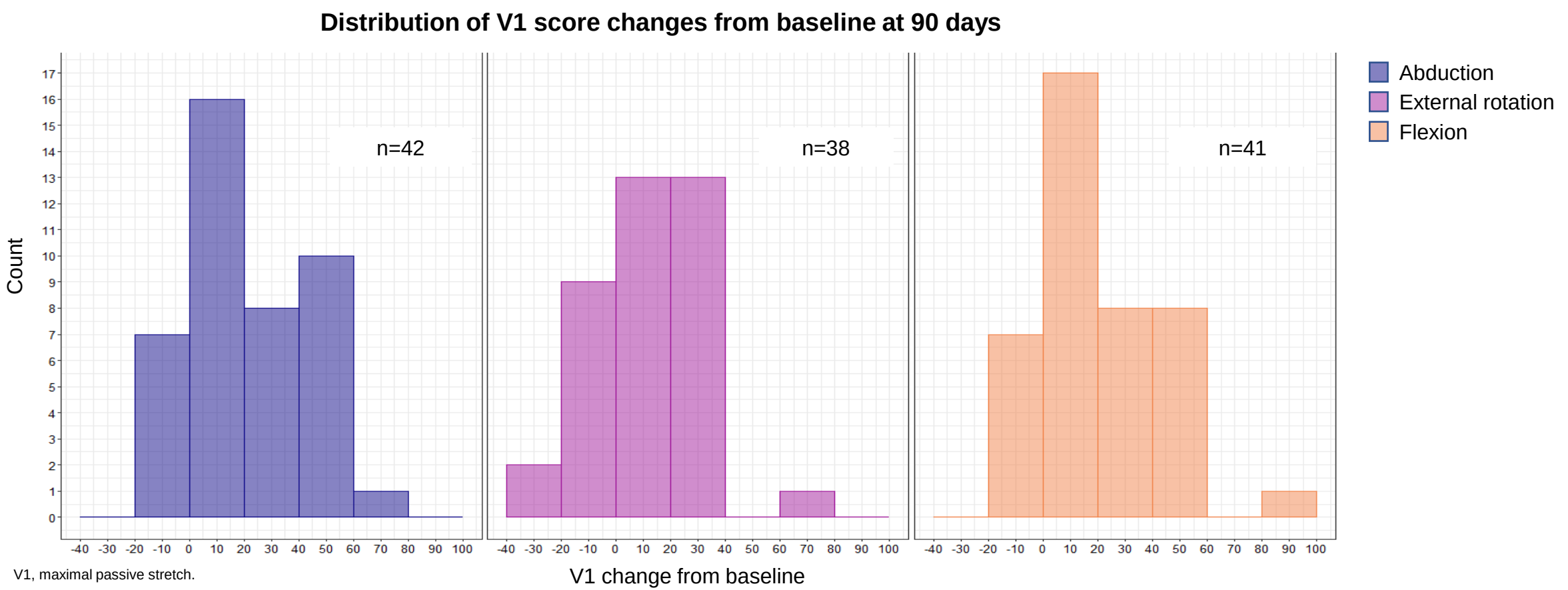


Outcome	90-day change n=40	*P*-value
V1 scores (IQR)		
Abduction	20.0 (10.0, 45.0)	<0.001
External rotation	15.0 (0.0, 33.8)	<0.001
Flexion	20.0 (10.0, 35.0)	<0.001

*Wilcox *P* value is reported.
GAS, goal attainment scale; IQR, interquartile range; ROM, range of motion, V1, maximal passive stretch.

Results: 90-Day Changes From Baseline (cont)

- 45%, 37%, and 41% of participants experienced >20° improvements in V1 abduction, rotation, and flexion scores at 90 days, respectively



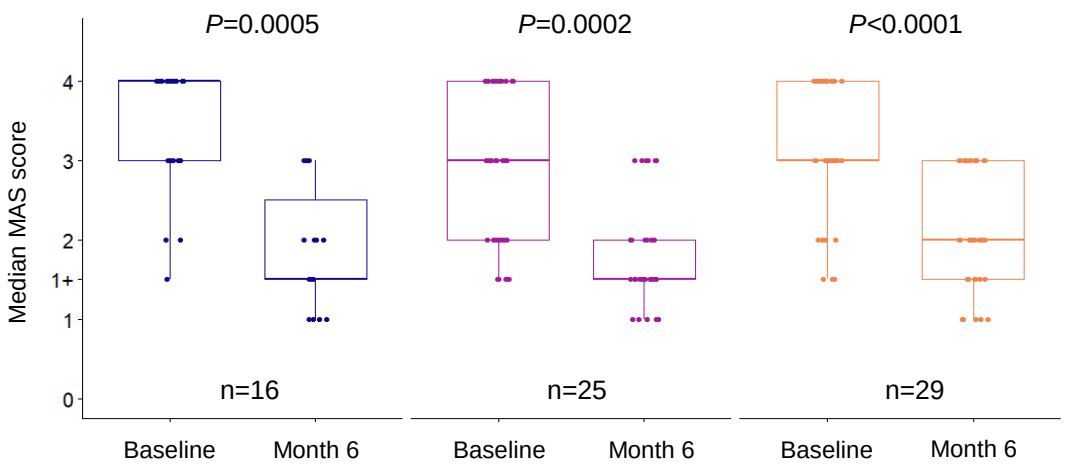
V1, maximal passive stretch.

Results: 180-Day Changes From Baseline

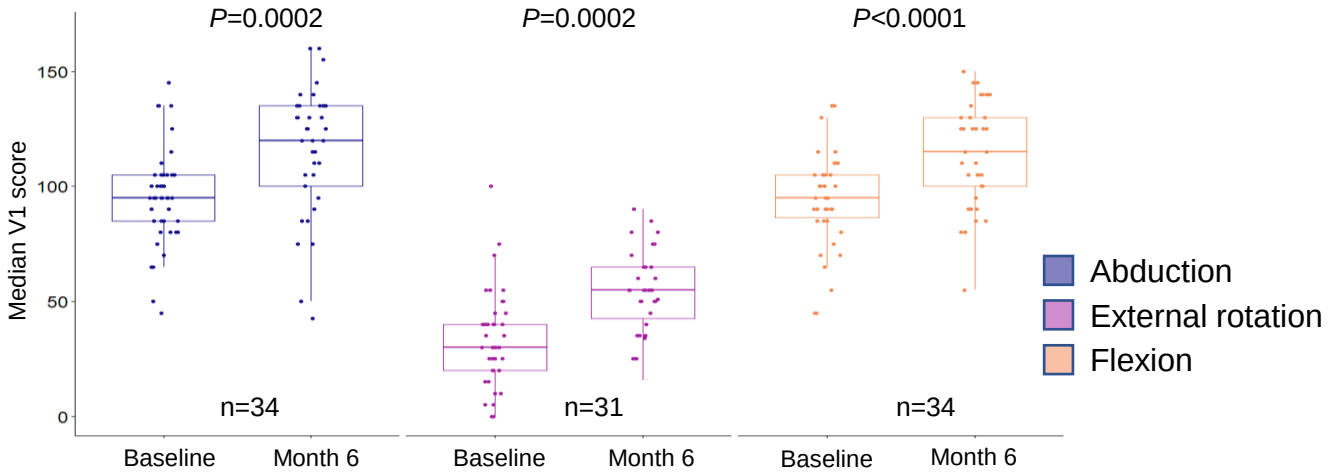
- Improvements in MAS and V1 scores* were sustained at the 6-month follow-up (*P*≤0.005)
- There was a numerical increase in mean improvement per patient in GAS scores at 180 days (13.8 points)

Outcome	Median MAS scores (IQR)	Median V1 scores (IQR)
Abduction	-1.50 (-2.10, -1.00)	17.50 (0.00, 33.75)
External rotation	-1.00 (-1.50, -0.50)	15.00 (2.50, 27.50)
Flexion	-1.00 (-1.50, -0.50)	15.00 (5.00, 32.50)

MAS scores at baseline and 180 days



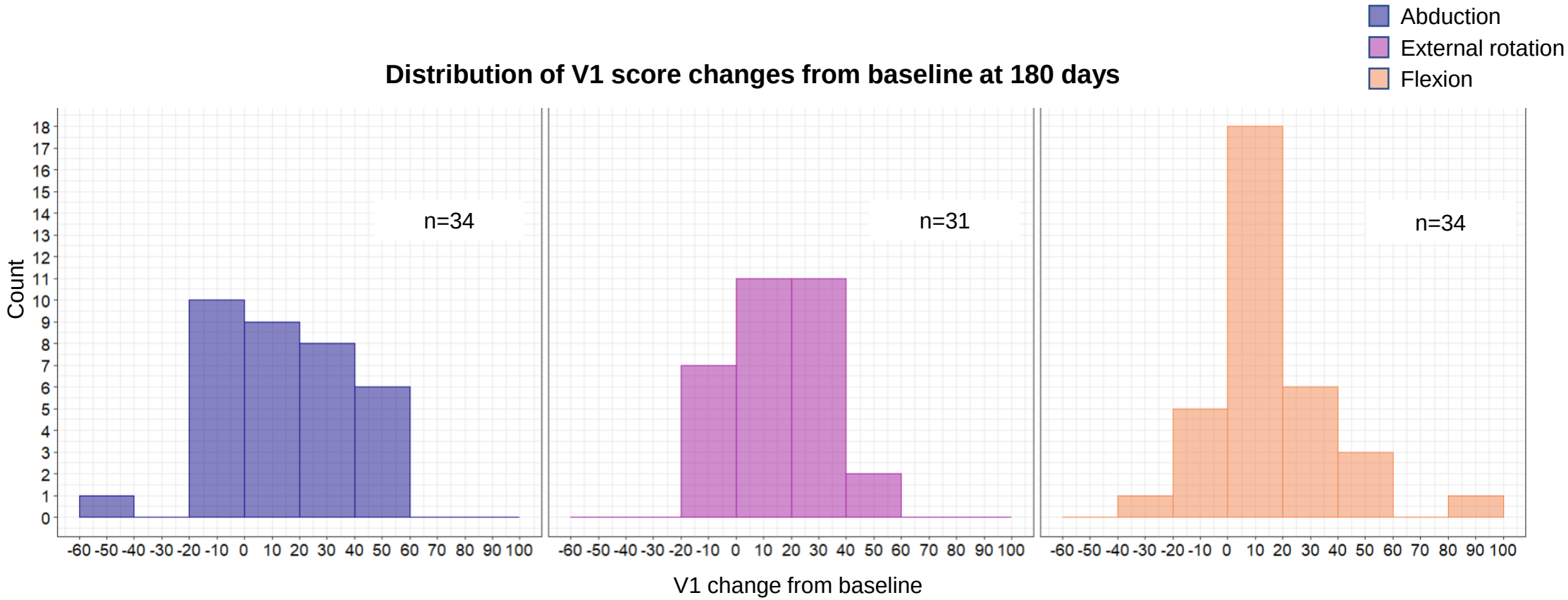
V1 scores at baseline and 180 days



*Wilcox *P* value is reported.
IQR, interquartile range; MAS, modified Ashworth scale; V1, maximal passive stretch.

Results: 180-Day Changes From Baseline (cont)

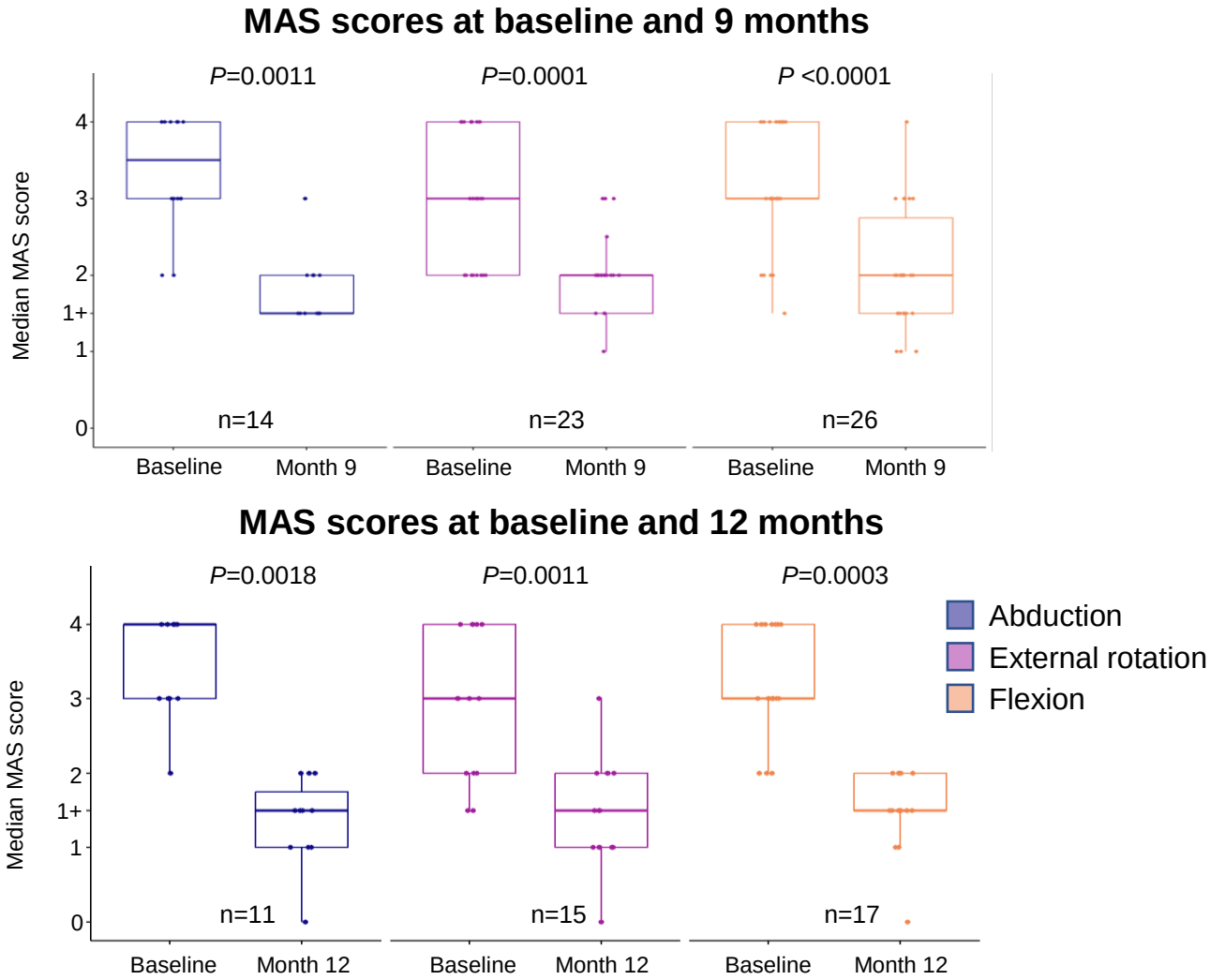
- 41%, 42%, and 29% of participants experienced >20° improvements in V1 abduction, rotation, and flexion scores at 6 months, respectively



V1, maximal passive stretch.

Results: Changes From Baseline to 9 and 12 Months

- Participants with follow-up data at 9 months and 12 months had sustained significant improvements in MAS scores at 9 (*P*≤0.0011) and 12 months (*P*≤0.0018)
- Significant sustained improvements were also observed in V1 scores at 9 (*P*≤0.001) and 12 months (*P*≤0.0005) across abduction, external rotation, and flexion measures*



*Wilcox *P* value is reported.
GAS, goal attainment scale; IQR, interquartile range; MAS, modified Ashworth scale; ROM, range of motion; V1, massive passive stretch; V3, fast catch.

Conclusions

1. Participants in the study had markedly reduced flexion, as well as external abduction and rotation, associated with increased tone which classically indicated clinical presence of severe spasticity

2. Percutaneous cryoneurolysis of the medial, lateral pectoral nerve, and/or suprascapular nerve was associated with improvements in shoulder ROM, spastic tone, and clinically meaningful[1] improvements in GAS scores at 90 and 180 days[1]

3. Improvements in shoulder ROM and spastic tone were maintained at later time points; longer follow-up is ongoing to confirm sustainability of improvements

1. López de Munain L et al. *Eur Neurol.* 2019;82(1-3):1-8.
GAS, goal attainment scale; ROM, range of motion.