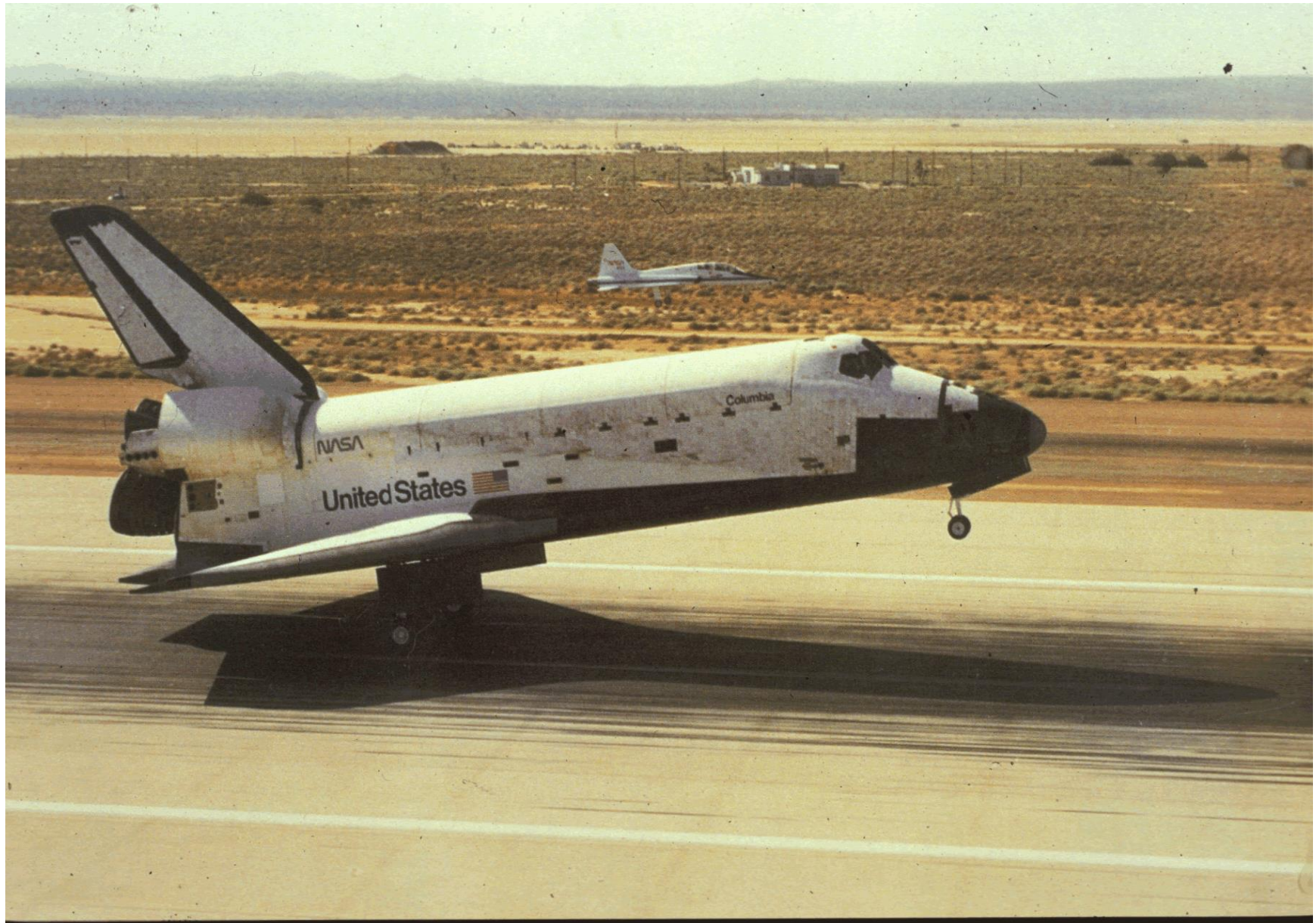


Short duration space flight = 7 to 10 days
Long duration space flight = 6 months

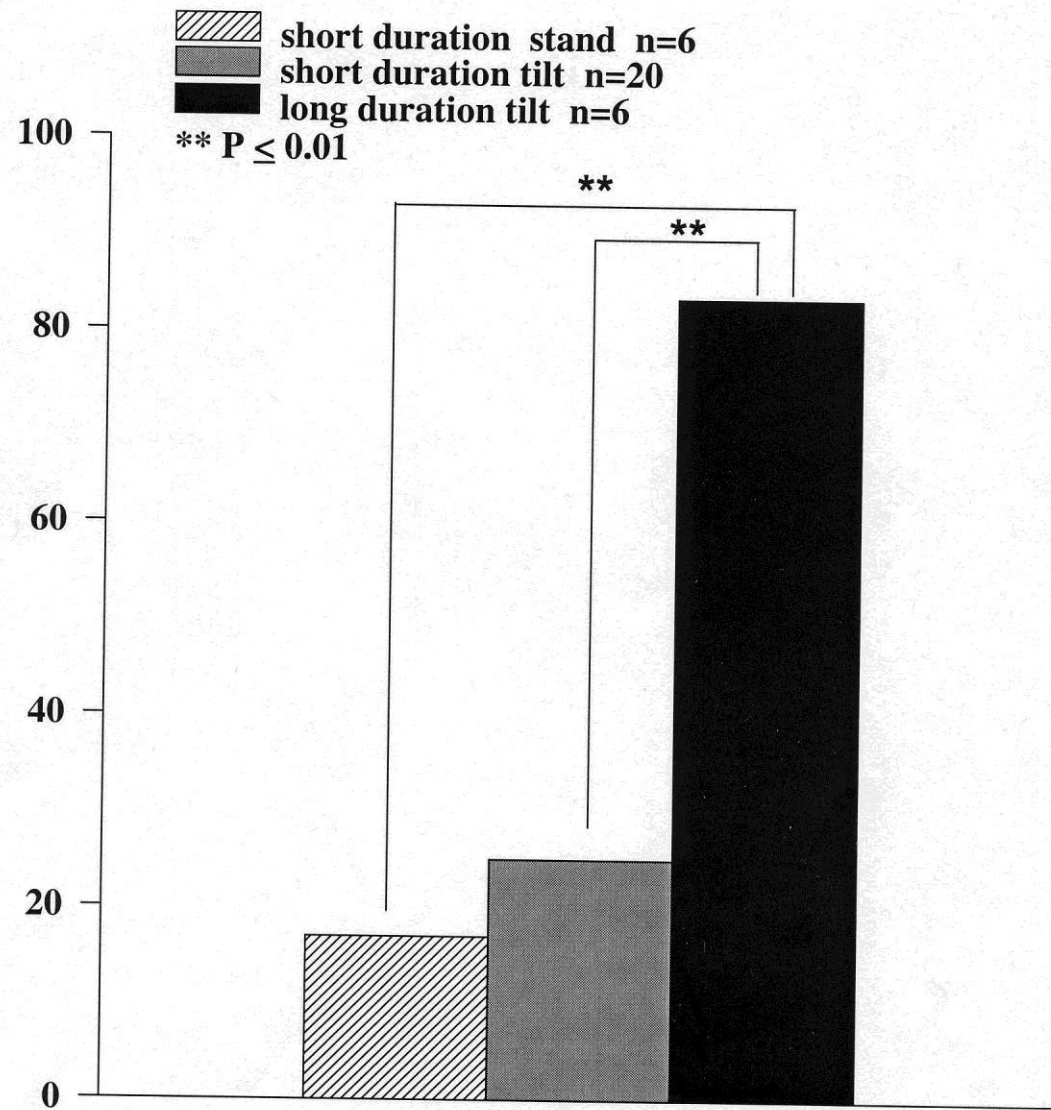




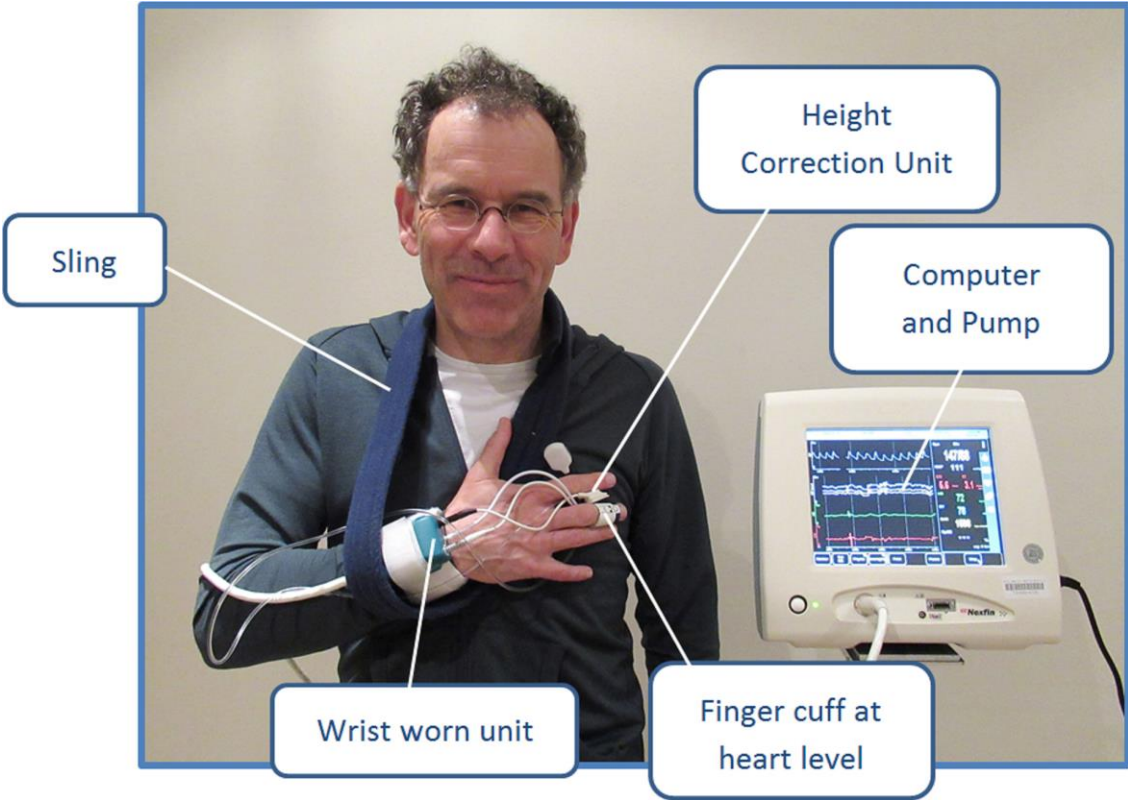




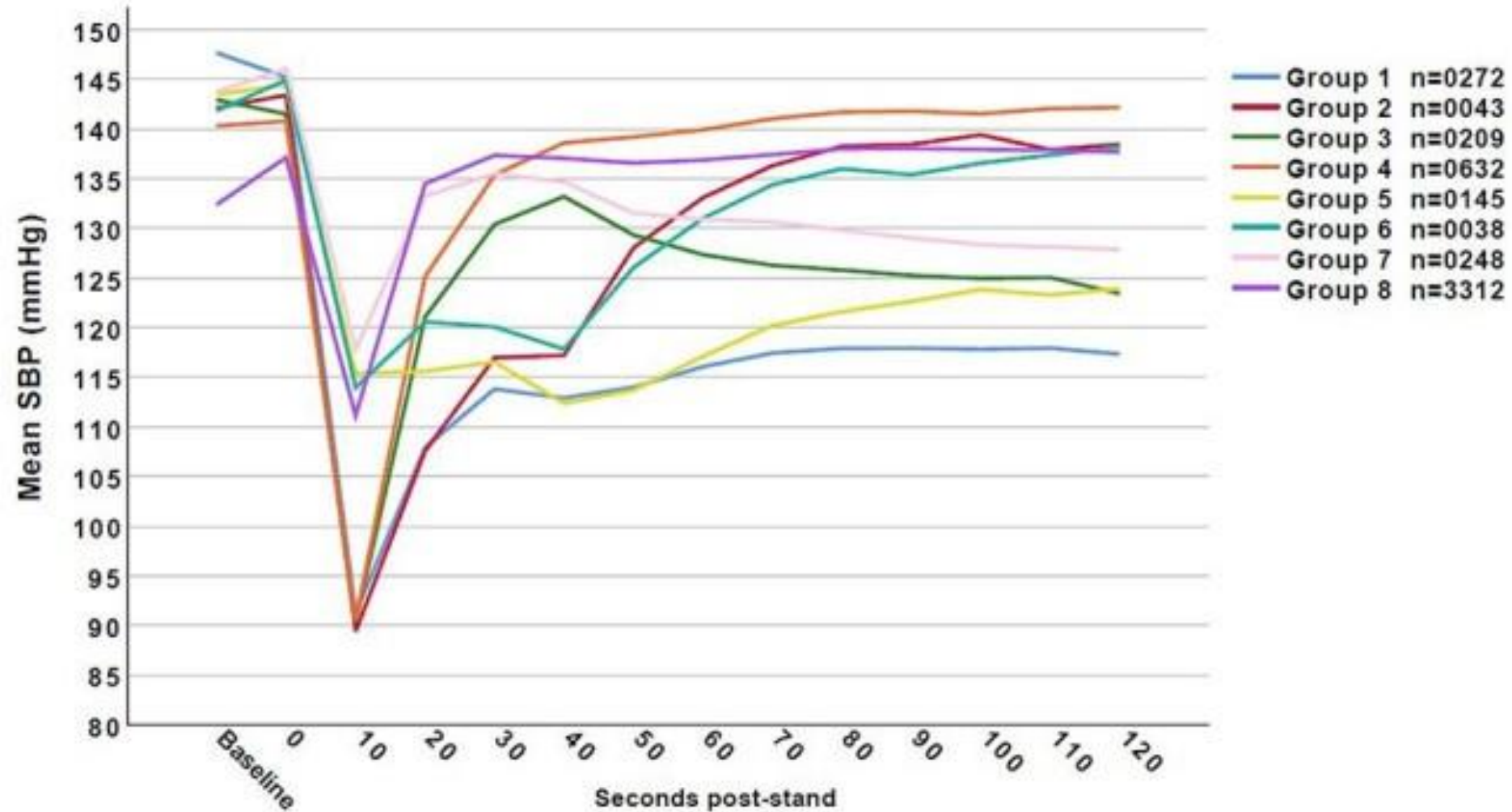
Incidence of Presyncope on Landing Day, %



Noninvasive beat-to-beat finger arterial pressure monitoring during orthostasis: a comprehensive review of normal and abnormal responses at different ages



Systolic blood pressure response to standing



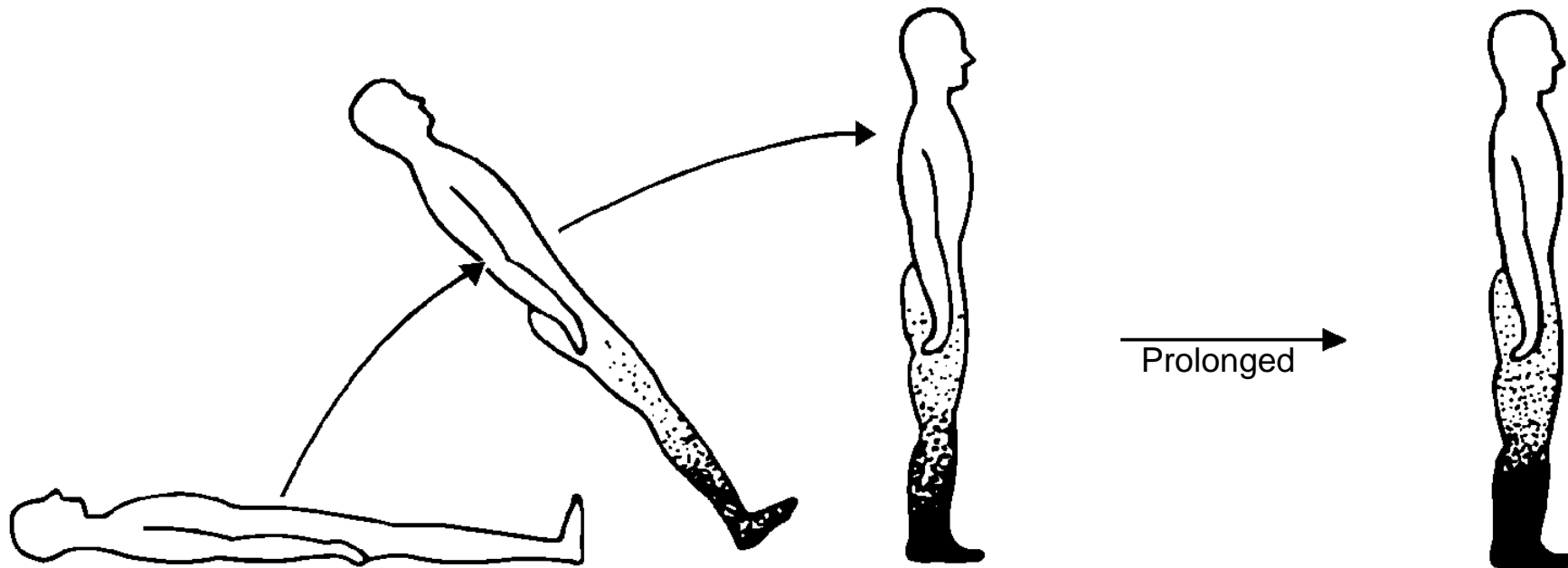


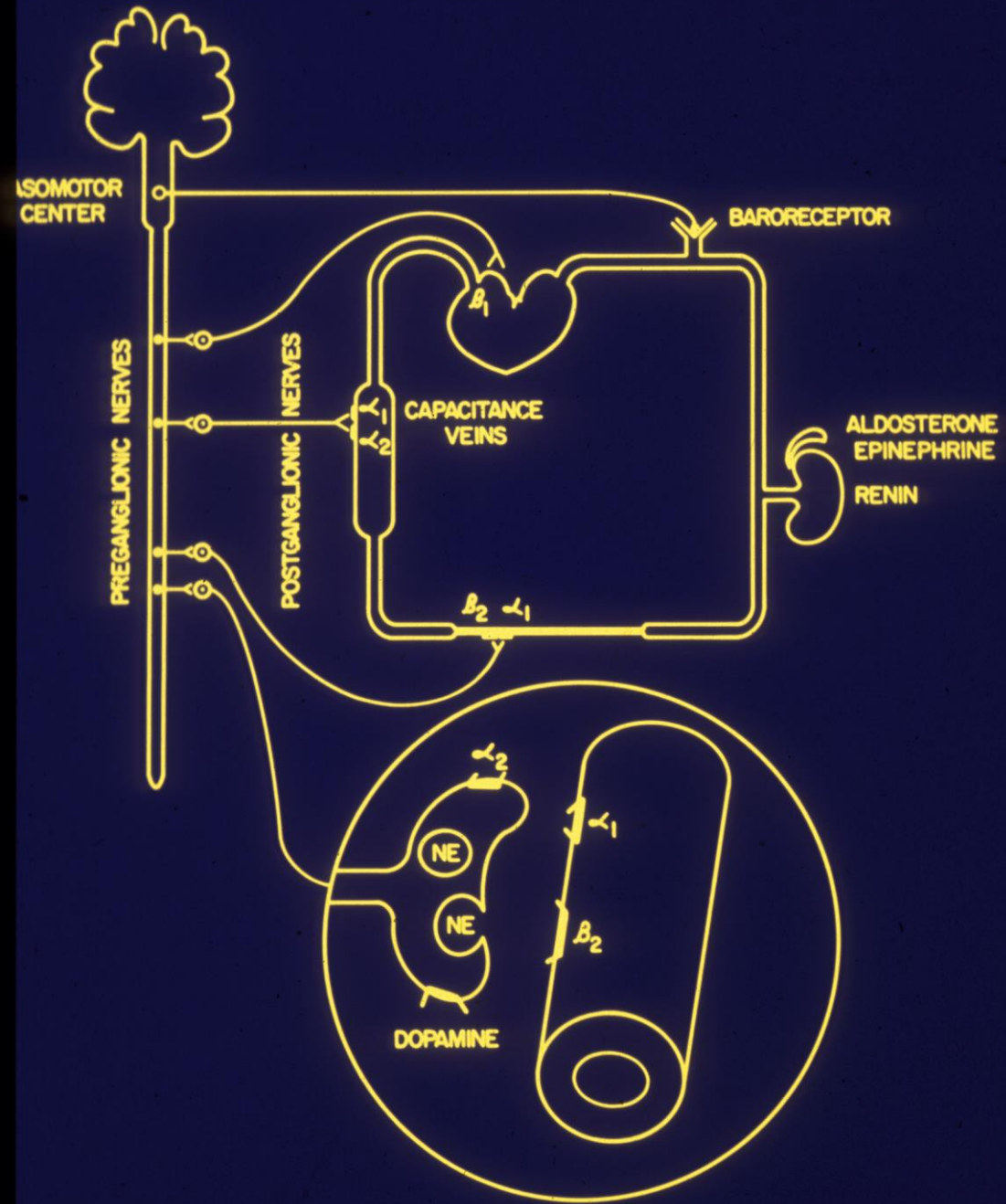


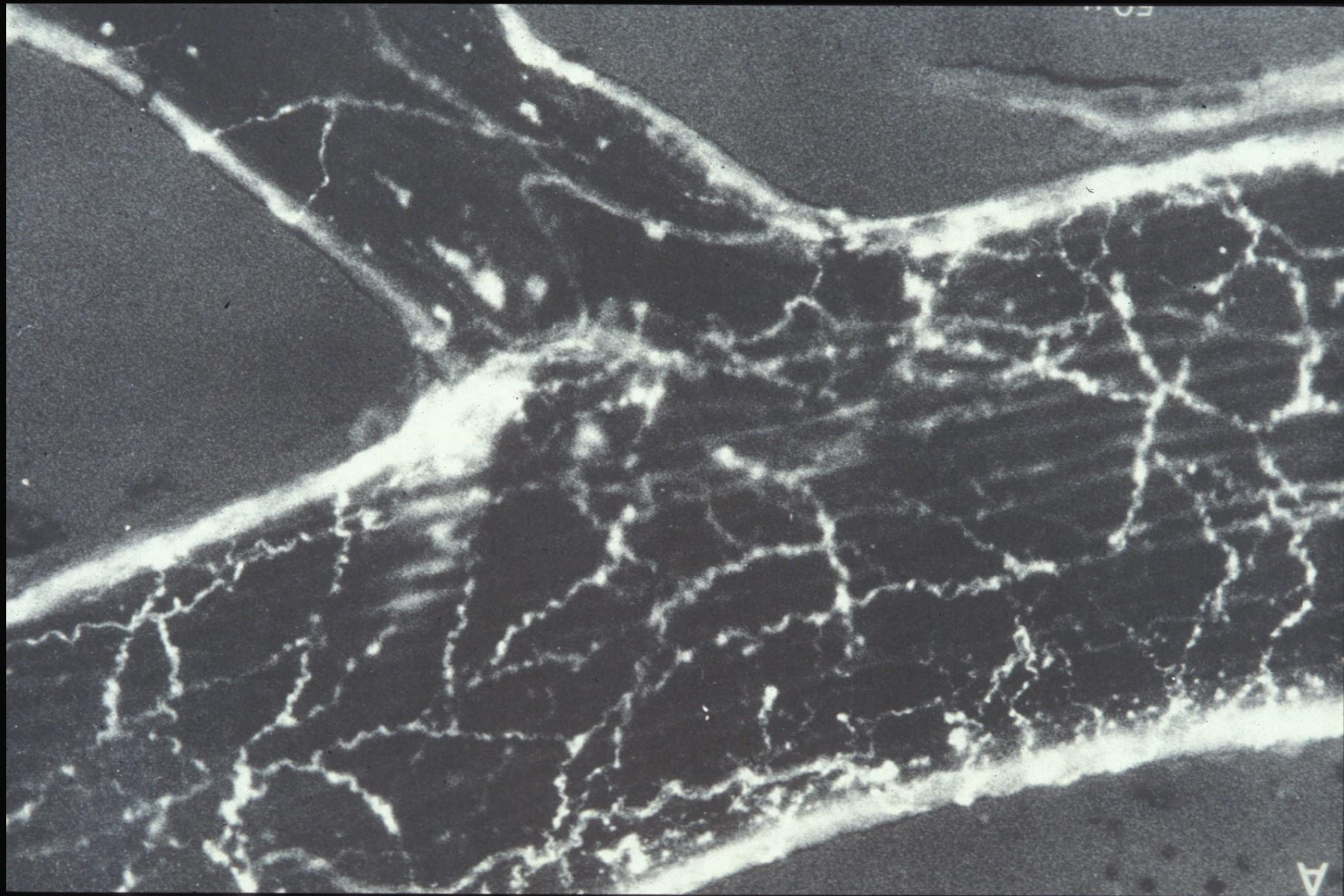
- ↓ Central Venous Pressure
- ↑ Sympathetic Activity
- ↑ Plasma Norepinephrine
- ↑ Vasoconstriction

- ↓ Central Venous Pressure
- ↓ Arterial Pulse Pressure
- ↑ Sympathetic Activity
- ↑ Plasma Norepinephrine
- ↑ Heart Rate
- ↑ Vasoconstriction
- ↑ PRA → Angio. II - Aldost.

- ↓ Central Venous Pressure
- ↓ Arterial Pulse Pressure
- ↓ Arterial Mean Pressure
- ↑ Sympathetic Activity
- ↑ Plasma Norepinephrine
- ↑ Heart Rate
- ↑ Vasoconstriction
- ↑ PRA → Angio. II - Aldost.
- ↑ Vasopressin







PARASYMPATHETIC SYMPATHETIC

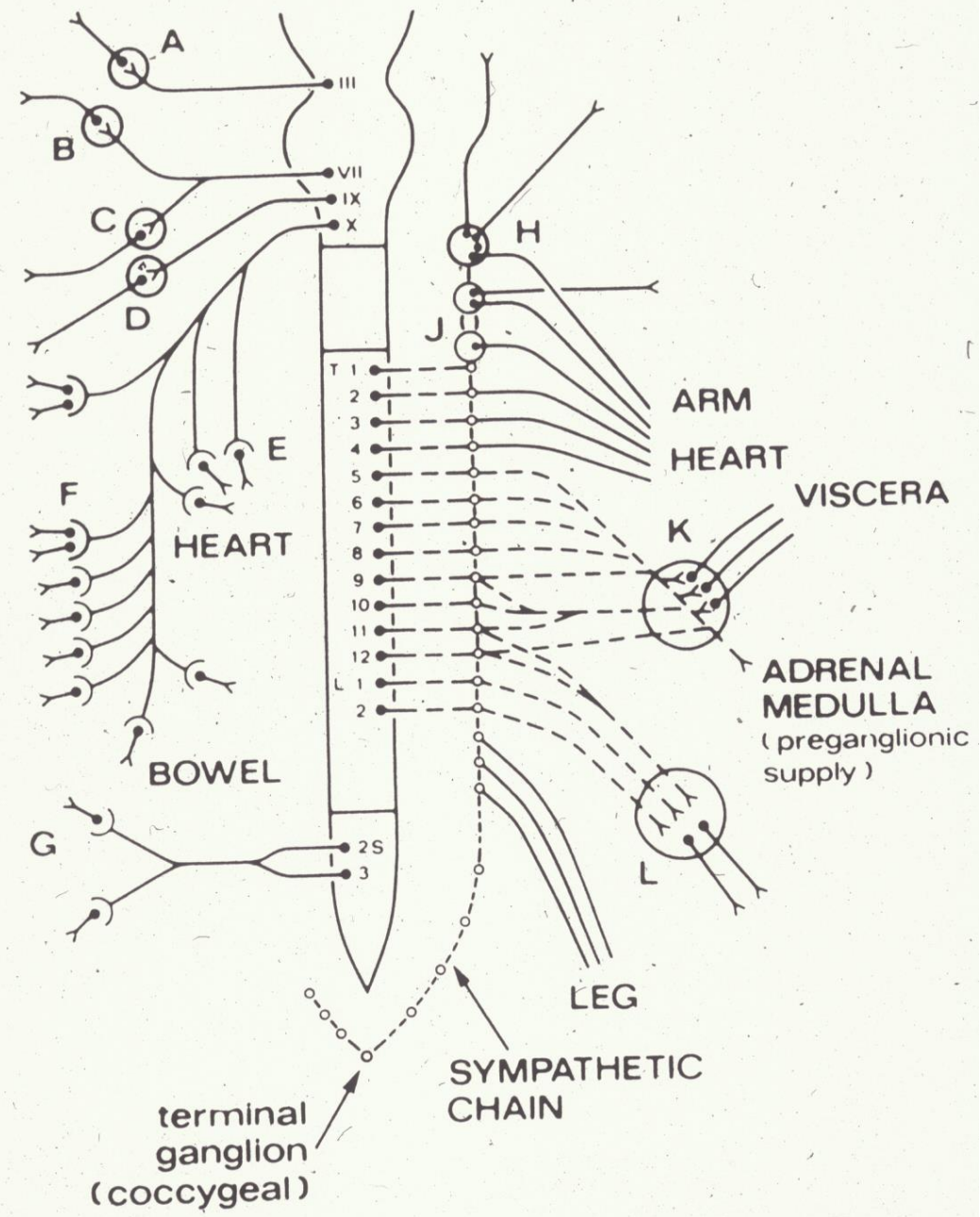
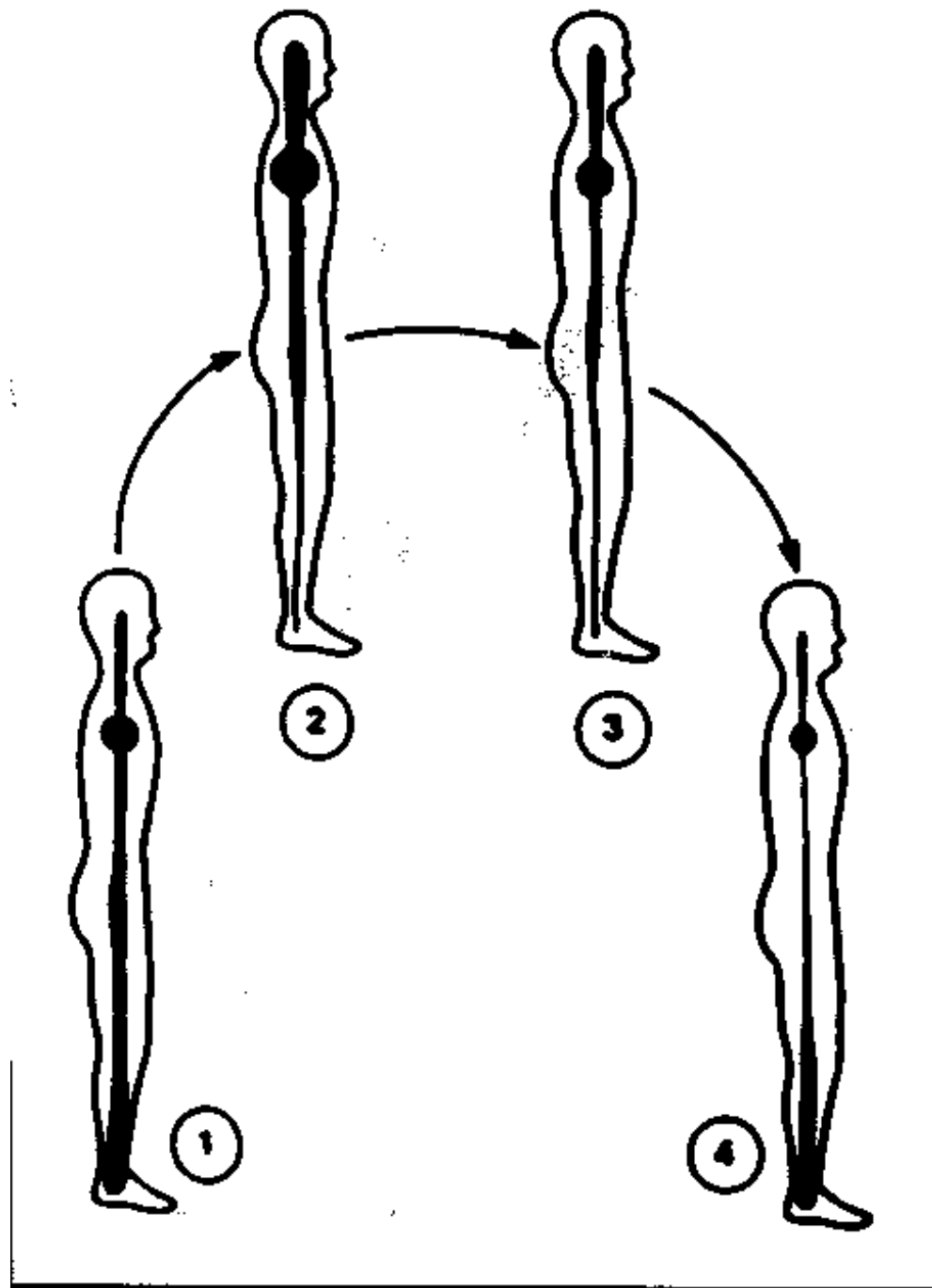




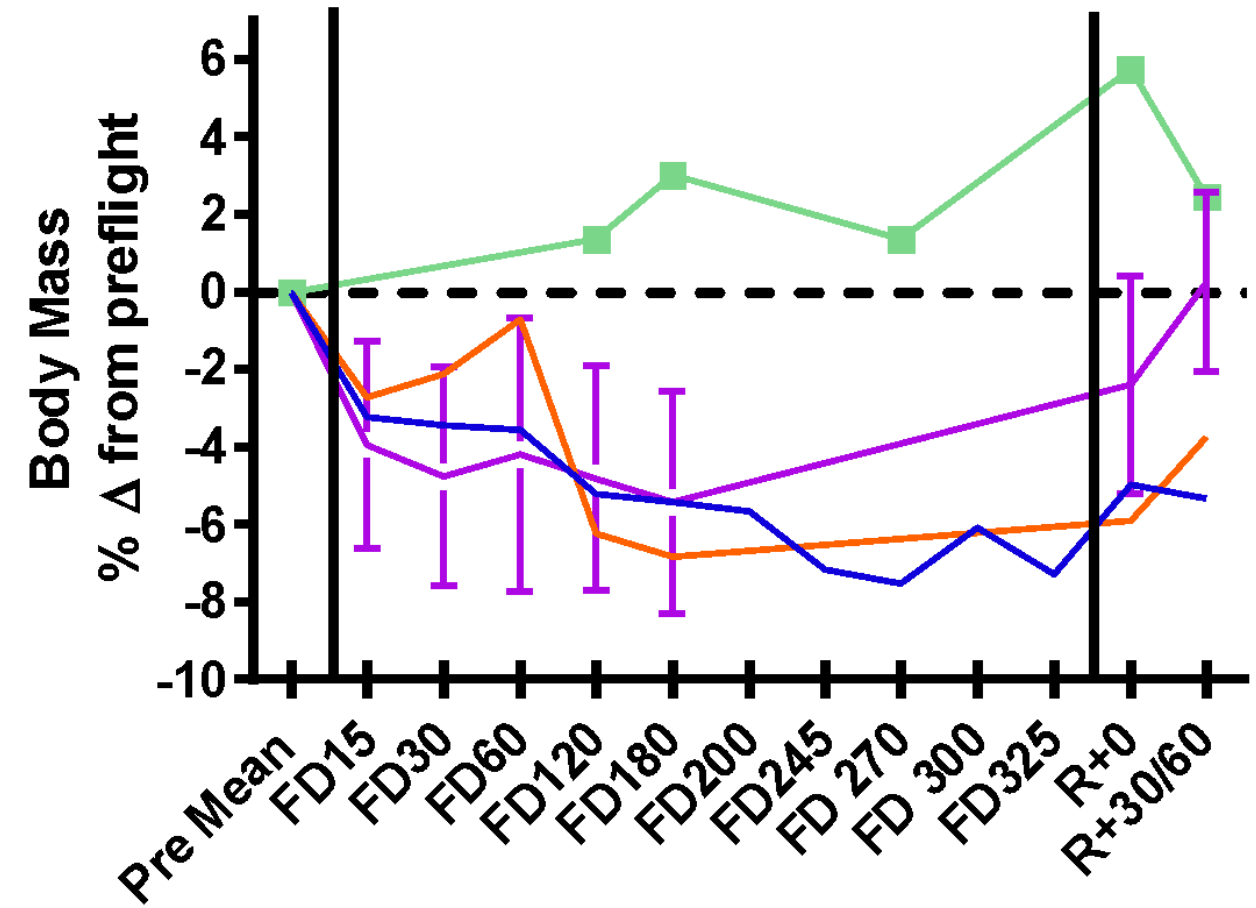


Fig. 1. Vasomotor disturbances affecting hands (“cold hands” – A, B) and feet (“cold feet” – C, D) in a 62-year-old lady with a 4-year history of MSA. Delayed capillary refill after digital pressure can be observed in panel D.





% body mass change for Mark (green), Scott (blue) and historic

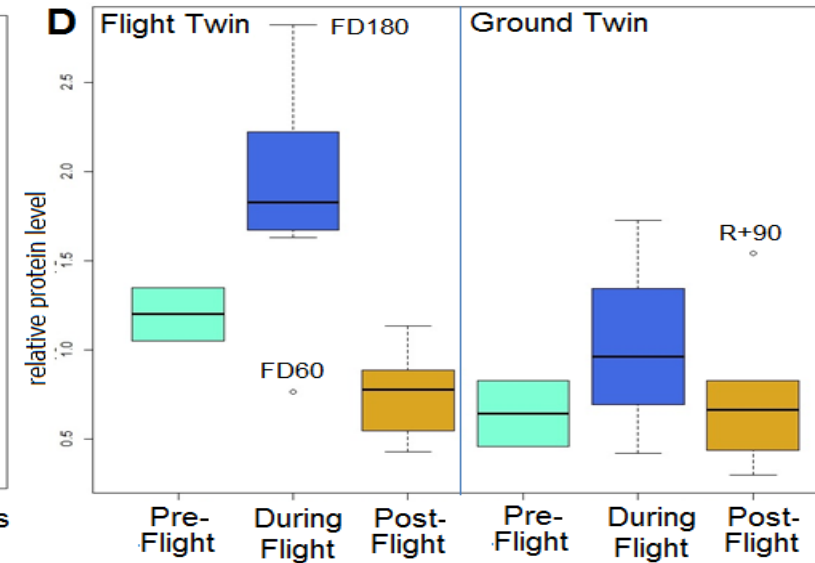
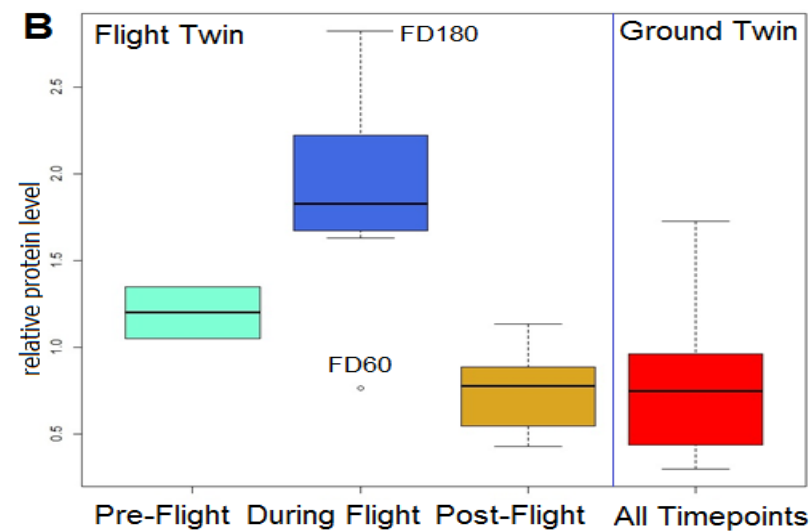
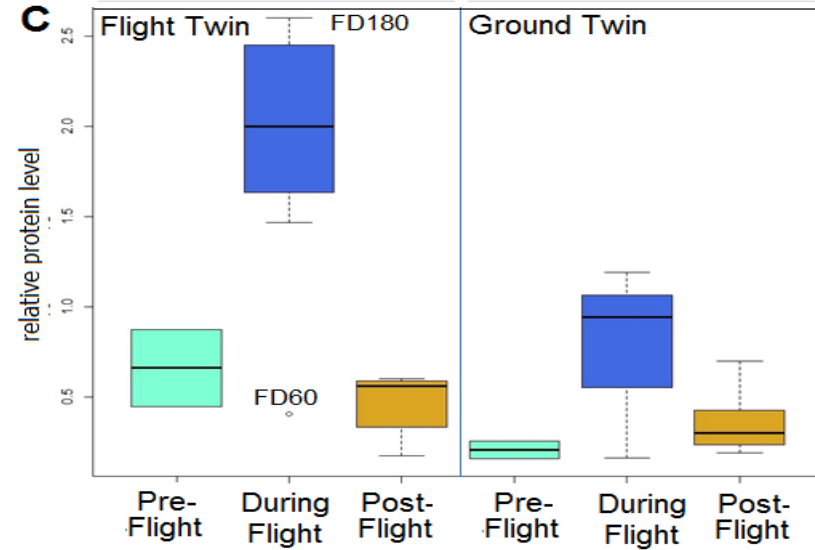
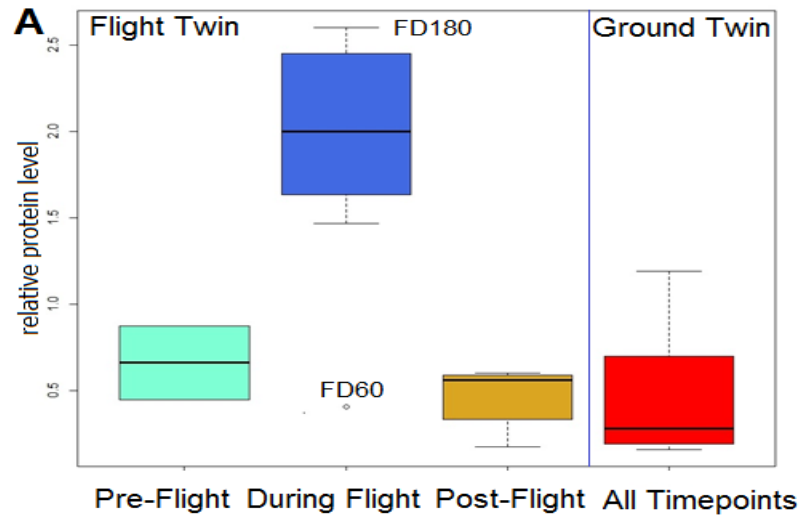


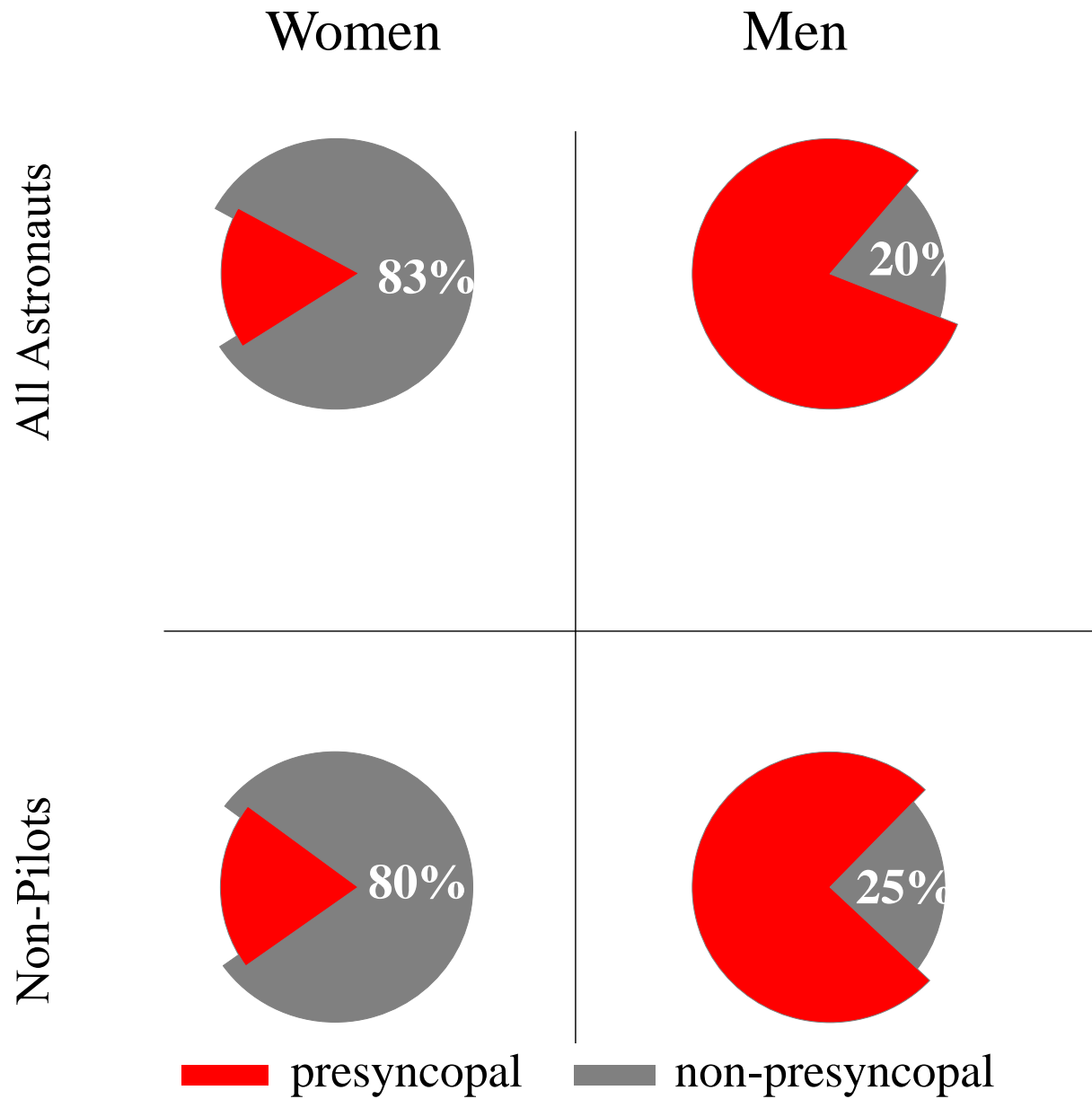
Collagen Type 3 alpha 1 and Collagen Type 1 alpha 1 are elevated in flight urine samples relative to ground samples

TYPE 3 α 1

**C
O
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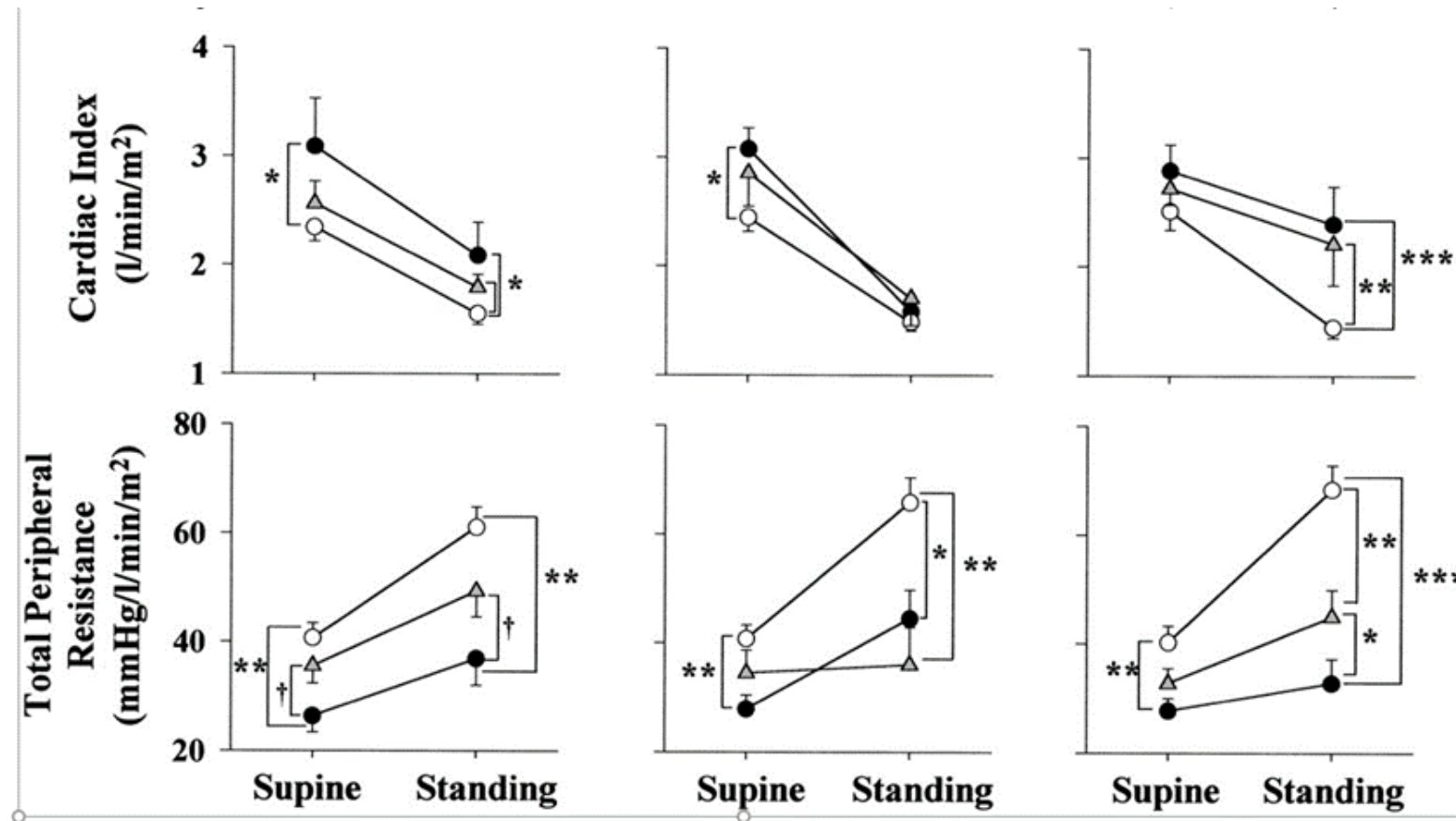
TYPE 1 α 1



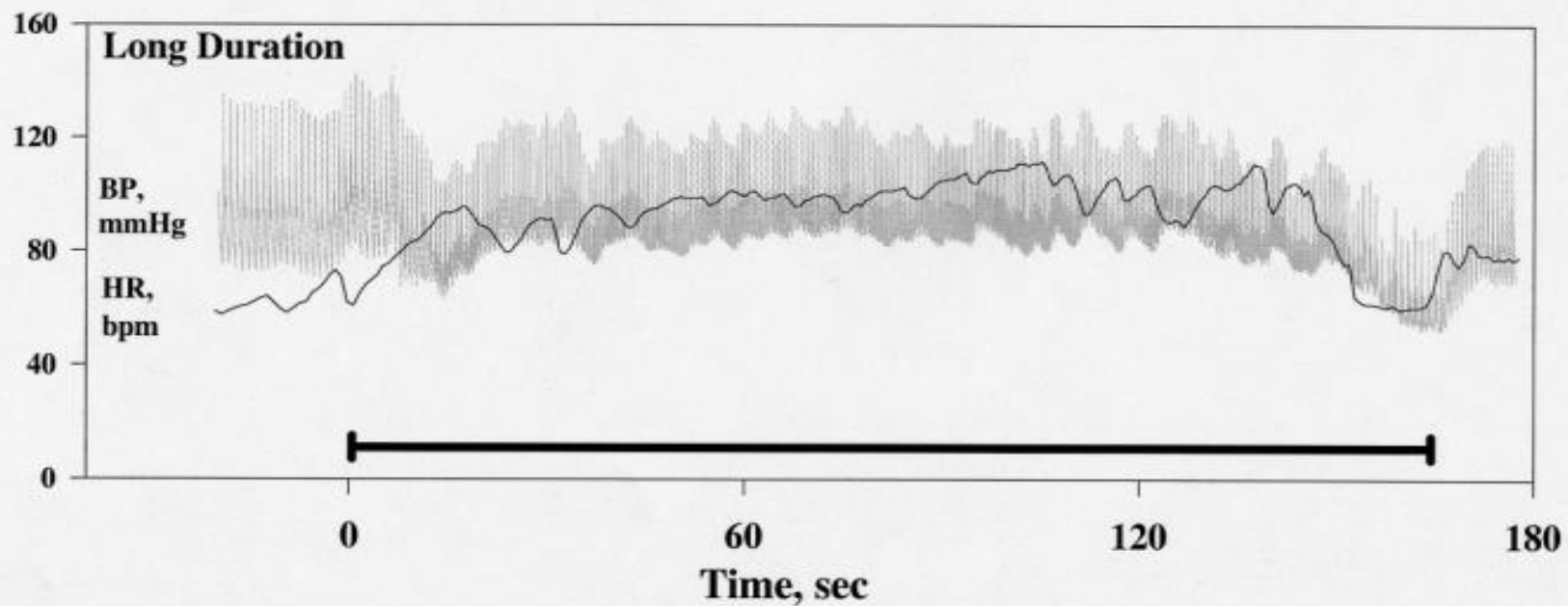
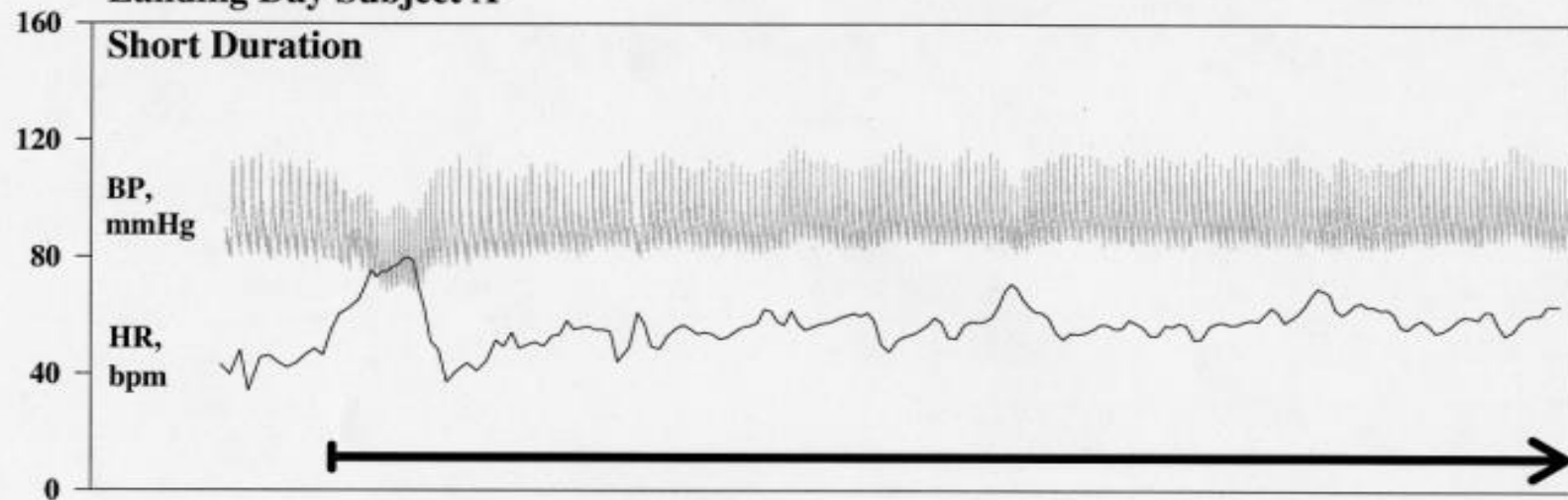




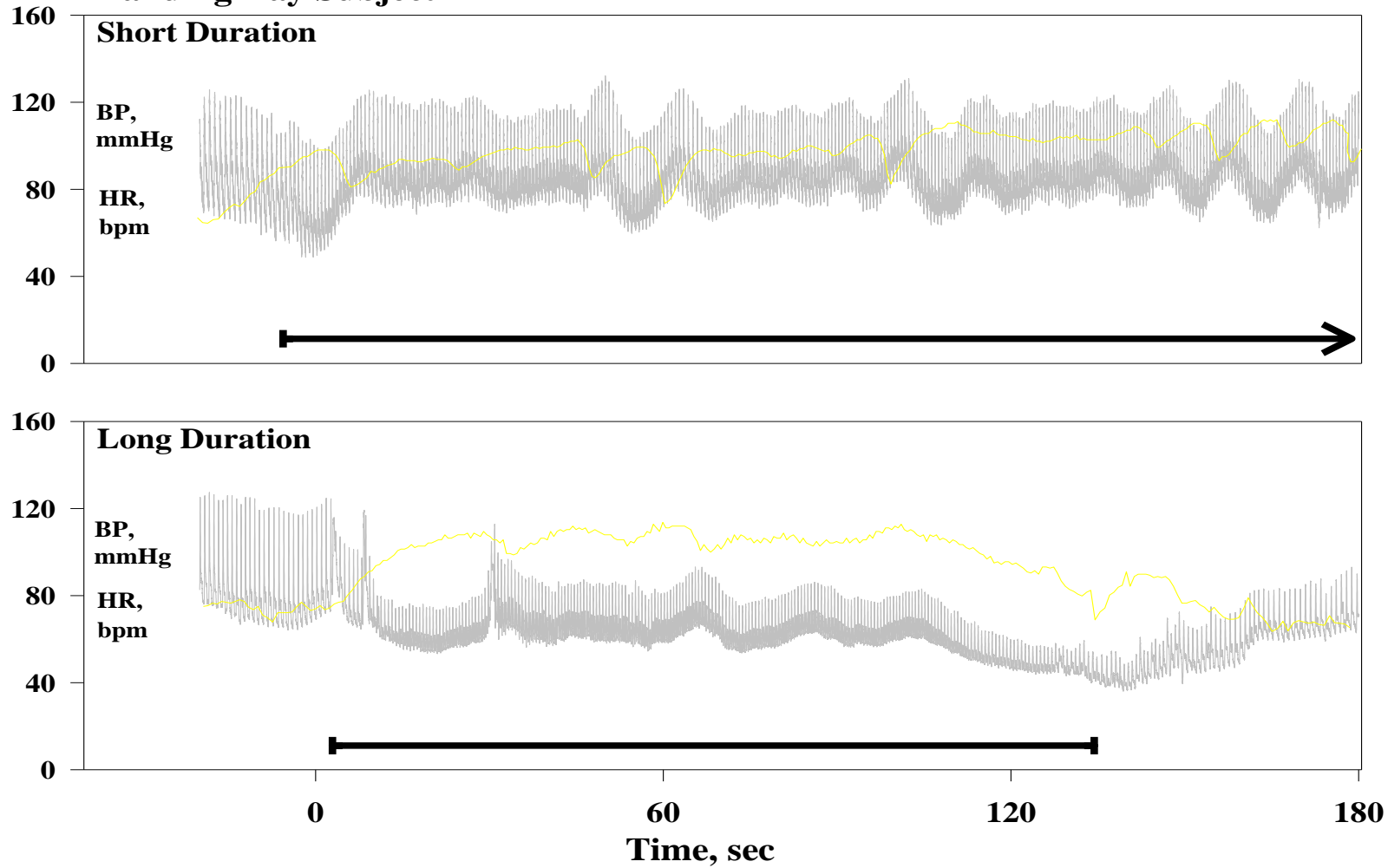
Women (closed circles) had lower peripheral resistance before (left) on landing day and 3 days later than men who were presyncopal or not presyncopal



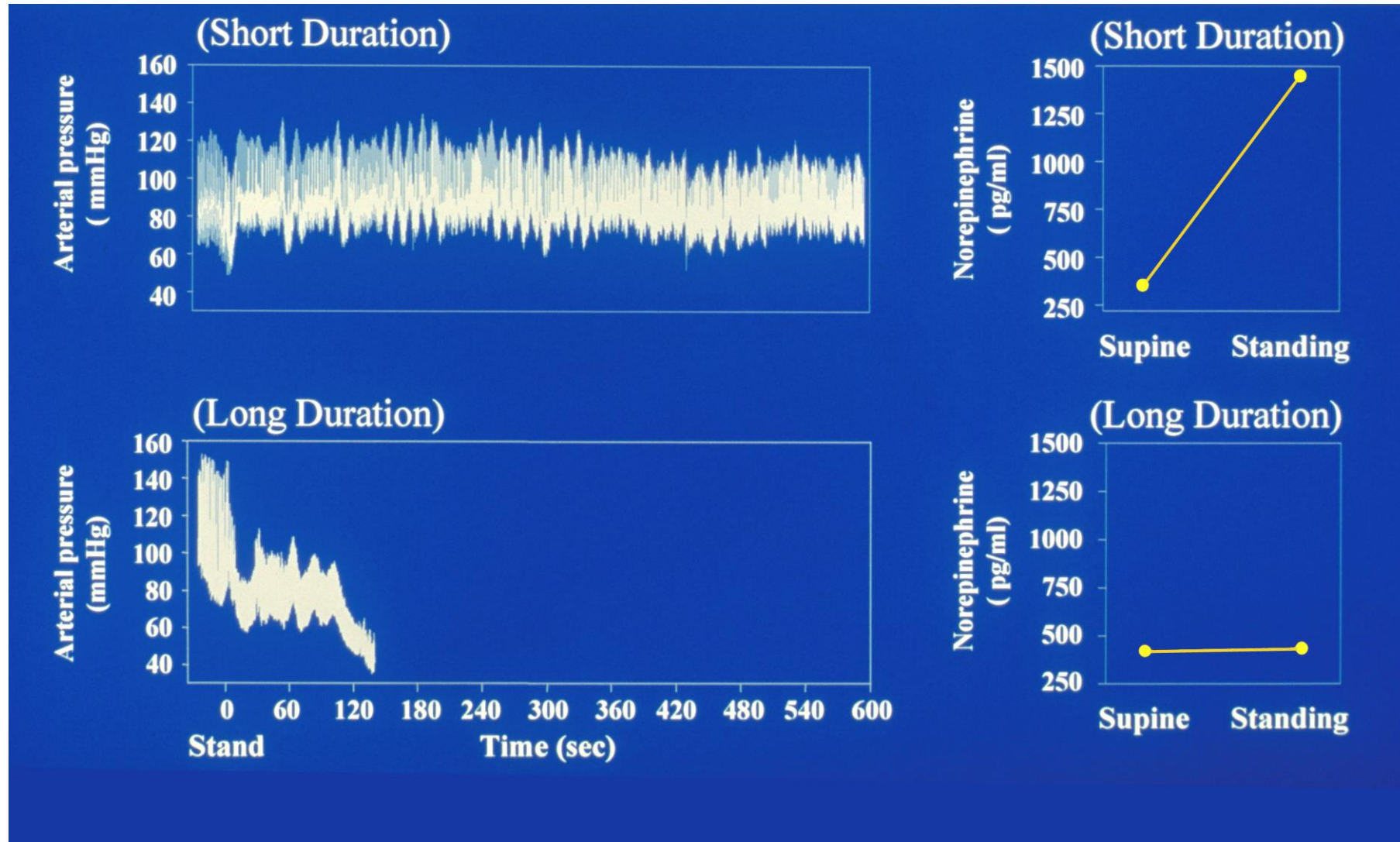
Landing Day Subject A

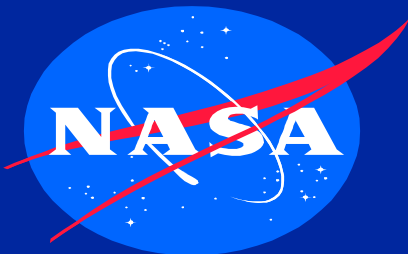


Landing Day Subject B

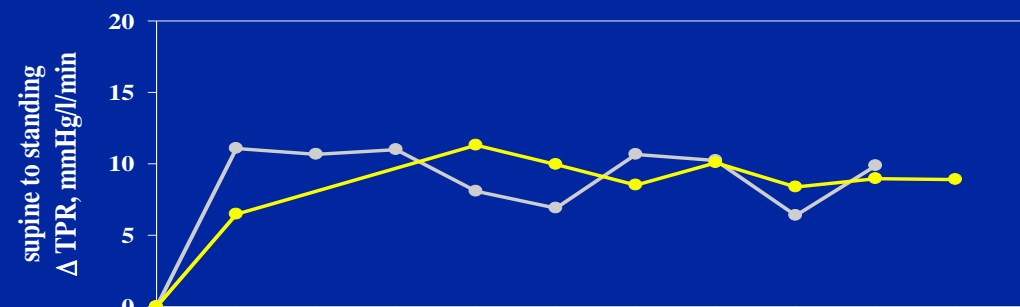
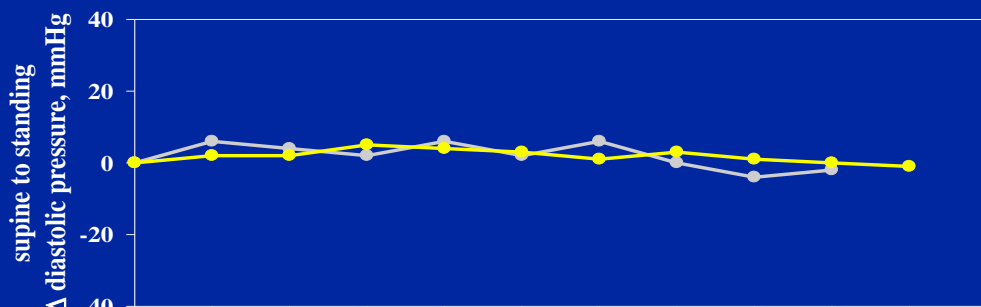
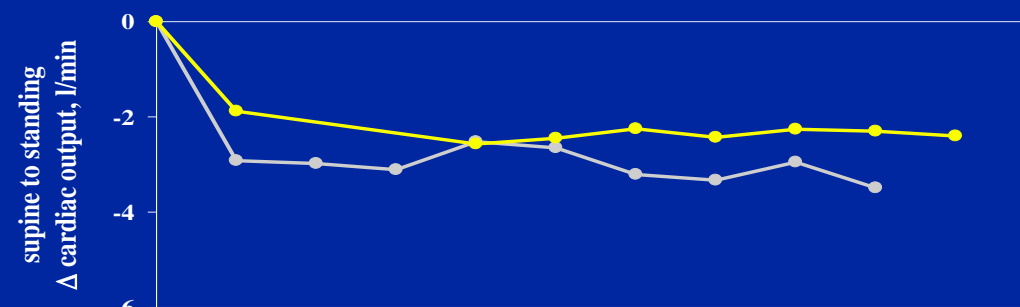
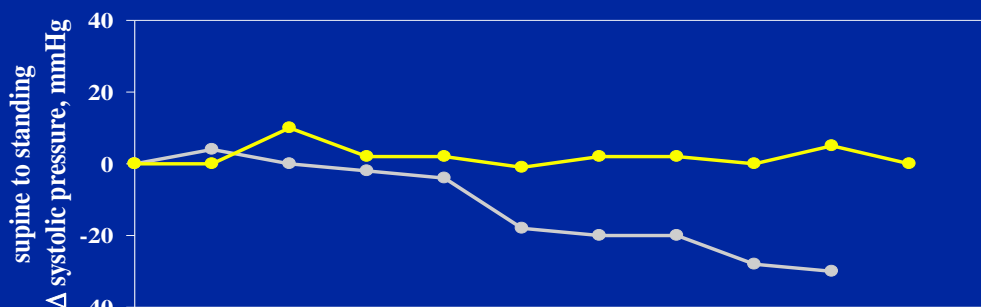
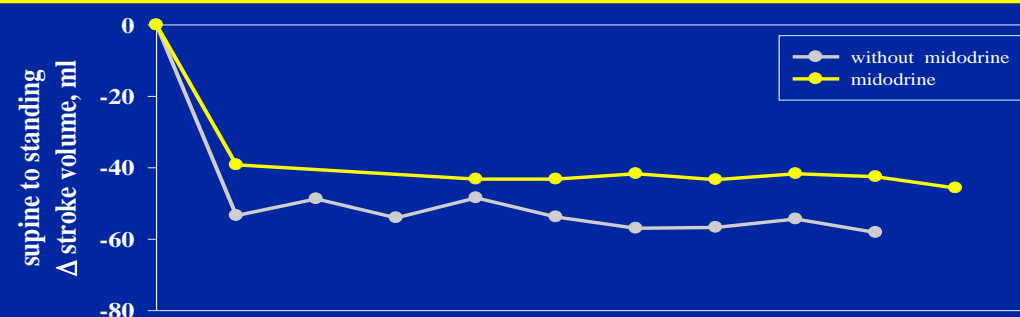
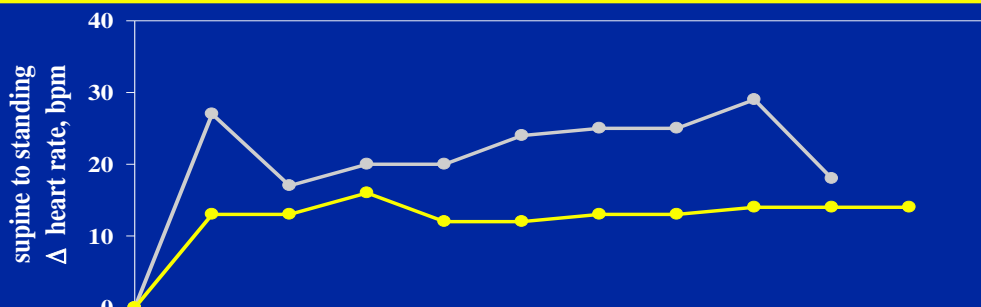


Response to Standing on Landing Day in One Subject





Response to standing with and without Midodrine after spaceflight



Syncope and lightheadedness on standing

Volume and vascular

- Eating disorders, laxatives, vomiting, diuretics
- Bed rest

Pex

Postural tachycardia

Hand vasoconstriction, foot vasoconstriction

Autonomic nerve responses

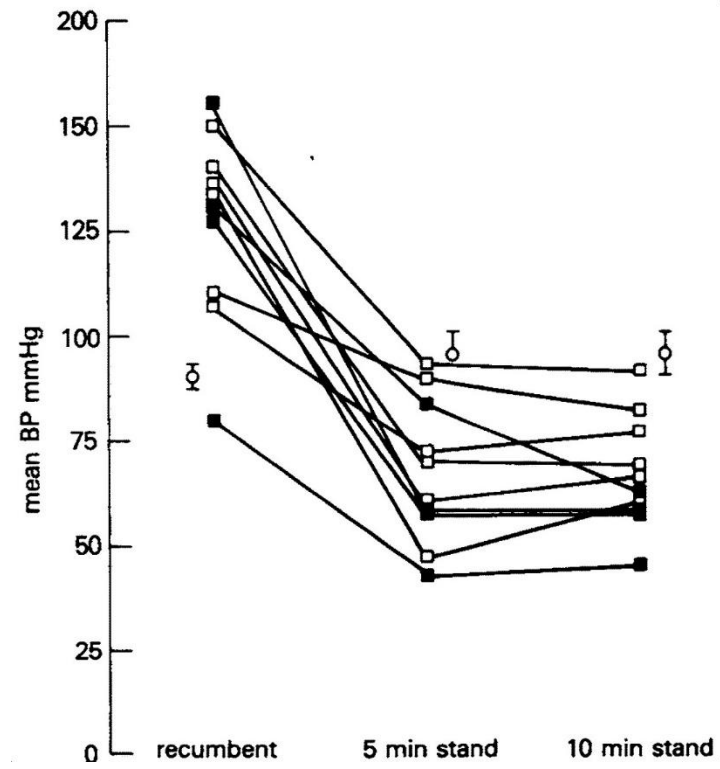
- Alpha-1 blockers (doxazosin, tamsulosin, labetalol, neuroleptics)
- Parkinsonism, MSA, diabetes, small fiber neuropathy

Pex

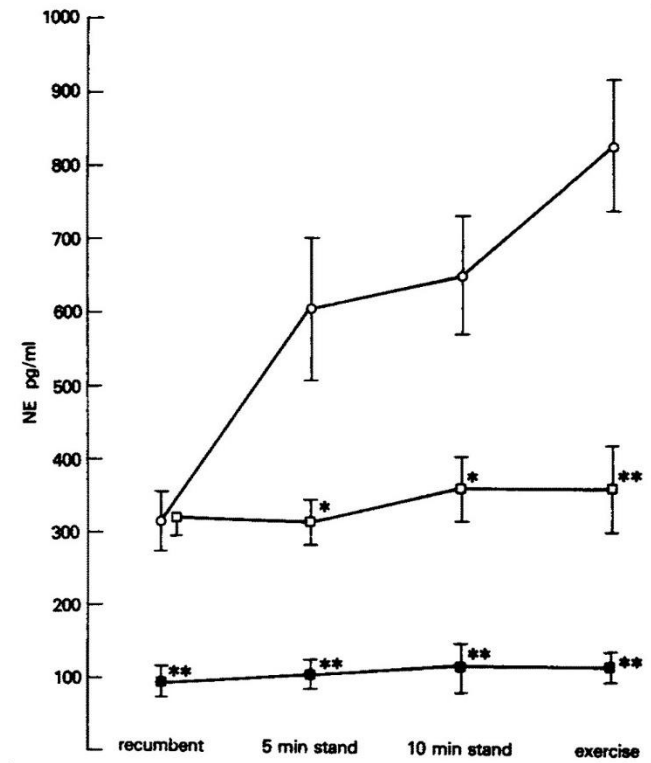
Small heart rate responses, poor pupil constriction, dry mouth,

Poor vasoconstriction in hand, rapid capillary refill in foot

Shy-Drager mean blood pressures recumbent and standing



Shy-Drager and Idiopathic Orthostatic Hypotension (IOH) norepinephrine



Ziegler MG et al. N Engl J Med 1977;296:293-297.

Testing to distinguish volume from neurogenic causes of postural lightheadedness and syncope

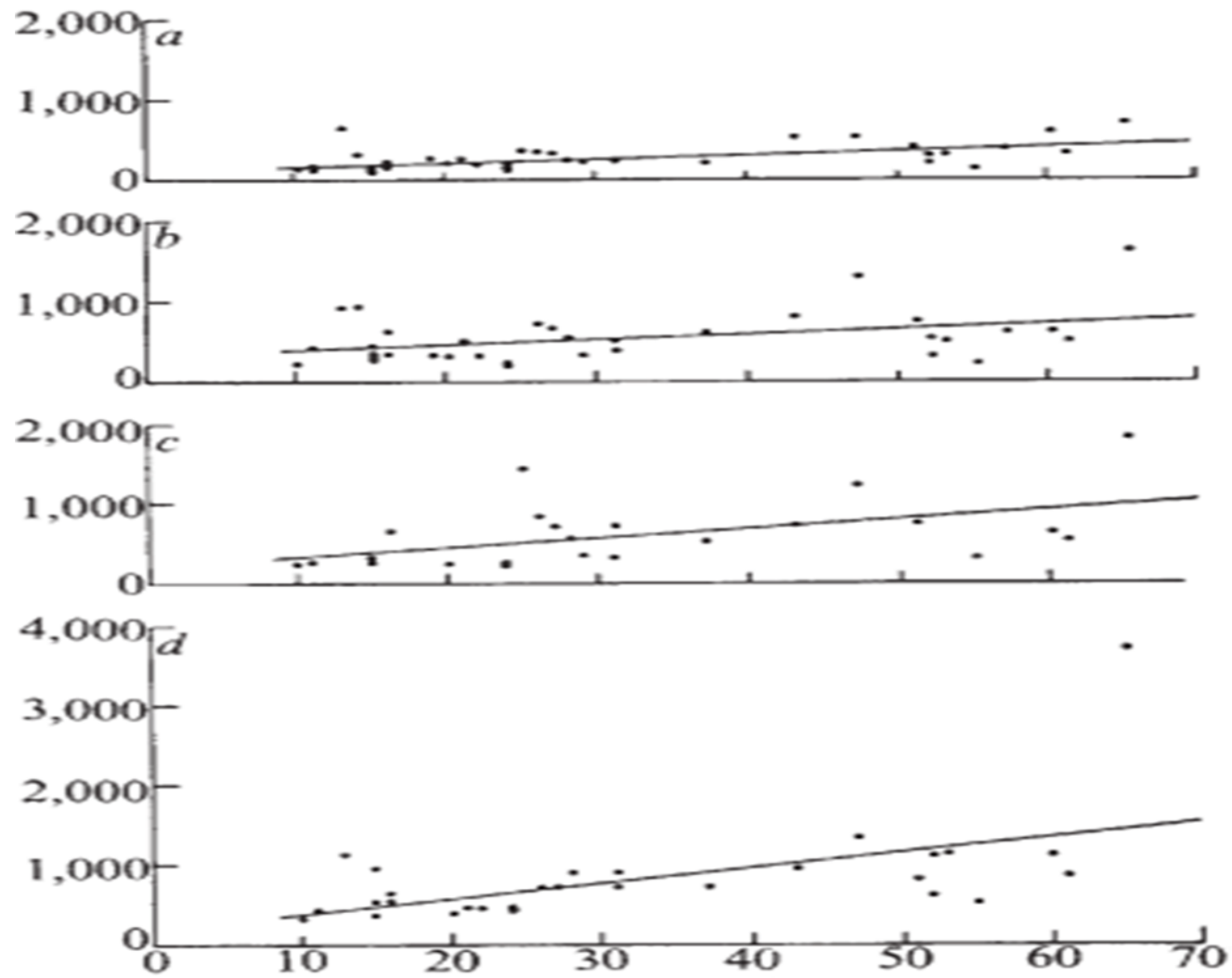
Volume

- CBC
- Urine Na⁺ / gram creatinine
- Renin
- Aldosterone

Neurogenic

- Heart rate response to standing
- Autonomic Pex
- Plasma norepinephrine

Plasma norepinephrine in subjects aged 12 to 70 while recumbent, standing 5 & 10 minutes and doing isometric exercise



Postural Hypotension

Neurogenic

Peripheral causes

Diabetes

Uremia

Autoimmune

CNS causes

Parkinsonism

Shy-Drager (MSA)

Stroke

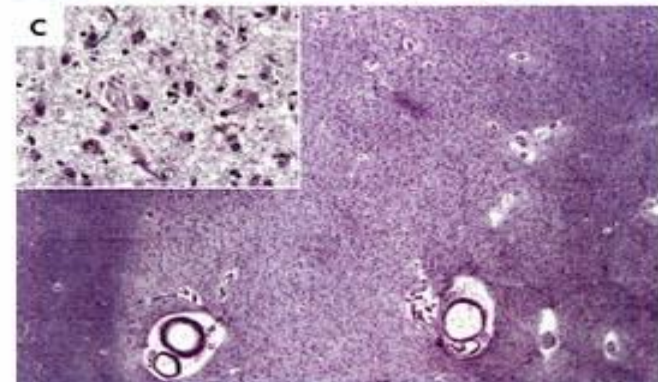
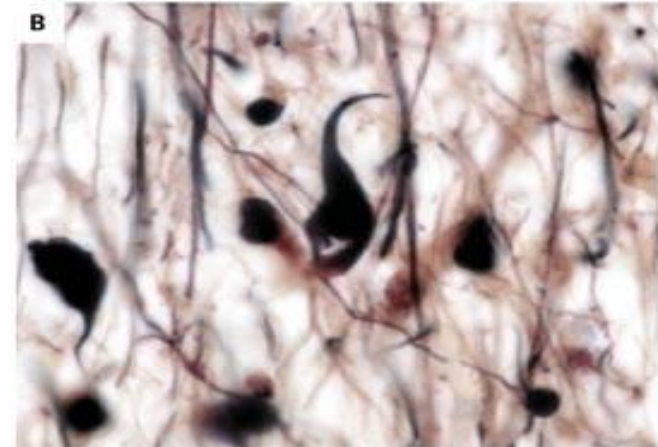
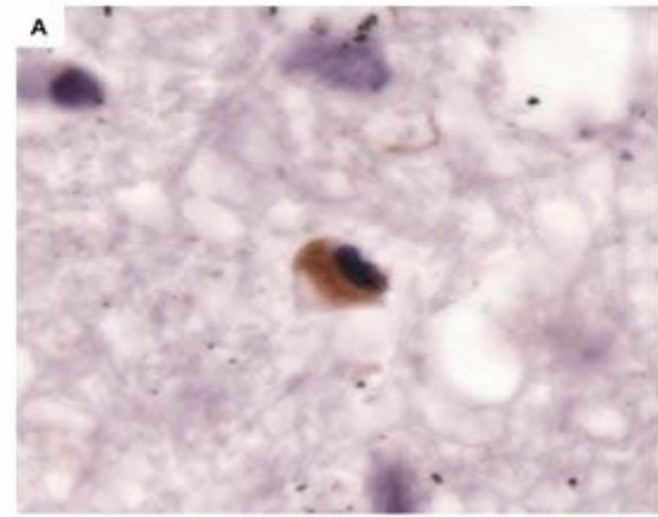
Tumor

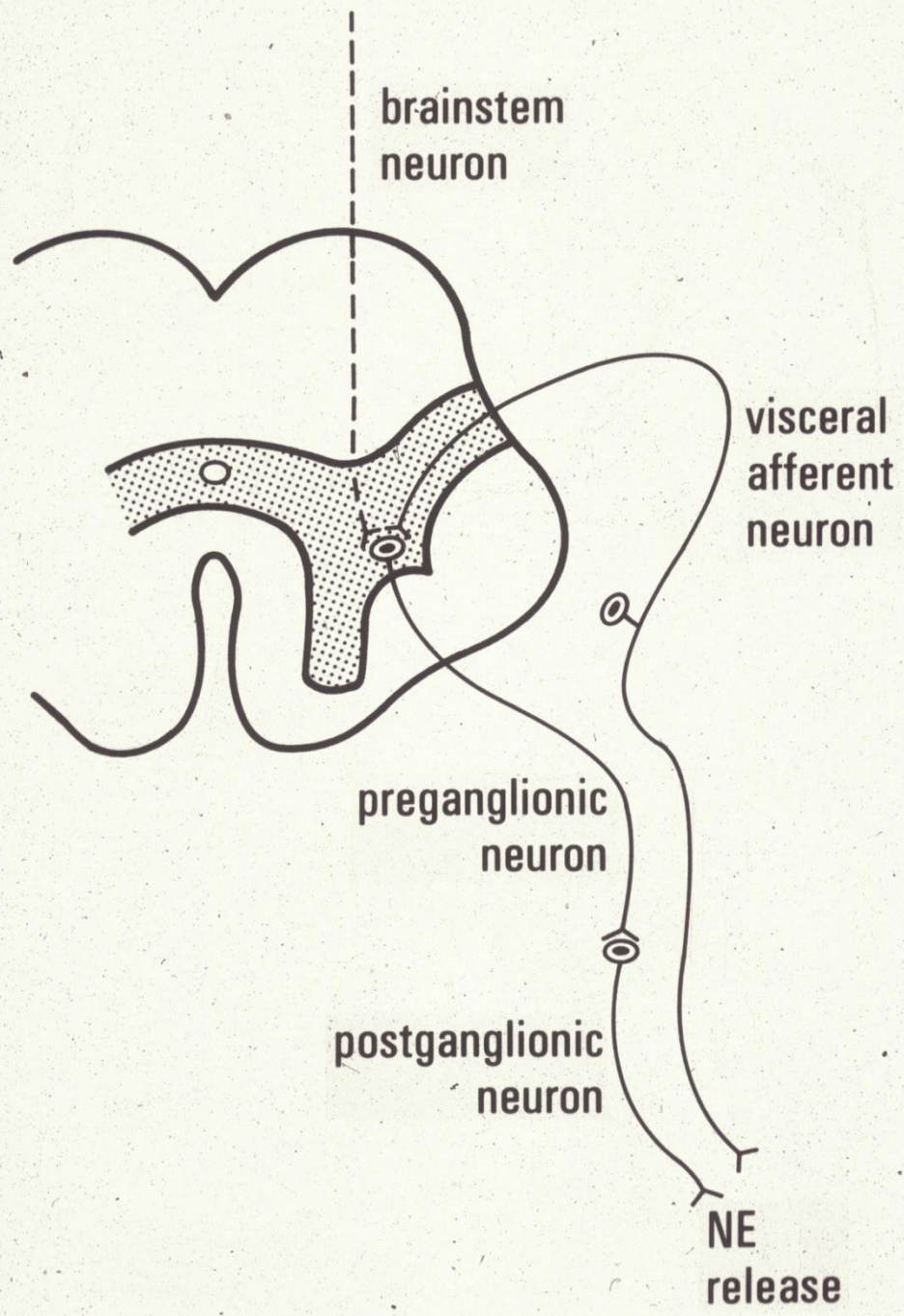
Syringomyelia

Spinal stenosis

Disc impingement

Alpha Synnuclein Staining in MSA glial cells





Parasympathetic failure

Pathology

Photophobia

Dry eyes

Dry mouth

Gastroparesis

Constipation

Bladder atony

Rx

- Sunglasses
- Artificial tears
- Liquids, dental hygiene
- Propulsive agents
- Bulk, osmotics, cathartics
- Catheterization
- Cholinergic agonists,
Cholinesterase inhibitors

Sympathetic Failure

Pathology

- Anhidrosis
- Skin vasodilation
- Hypoglycemia
- Erectile dysfunction
- Receptor supersensitivity

Rx

- Avoid overheating
- Avoid cold
- Food
- Alprostadil injection
- Pressors

Postural Hypotension

Vasodilation

- Heat & Fever
- Acidosis
- Drugs
- Infection

Volume Therapies

- Average American diet (9 gm NaCl + carbohydrate)
- Fludrocortisone (Florinef)
- Compression hose (waist high)

Pressor therapies

- Isometric exercise (both short and long term)
- Morning glass of water
- Cold and avoid heat
- Caffeine
- Midodrine if norepinephrine is low
- Droxidopa if norepinephrine is low

Therapy for recumbent hypertension

- Avoid PM caffeine and pressors
- Daytime support hose removed at night
- Tilt head of bed up
- Give routine antihypertensives at night
- Add short-acting nighttime antihypertensives such as captopril, 25 mg losartan

Astronaut protocol to prevent hypotension

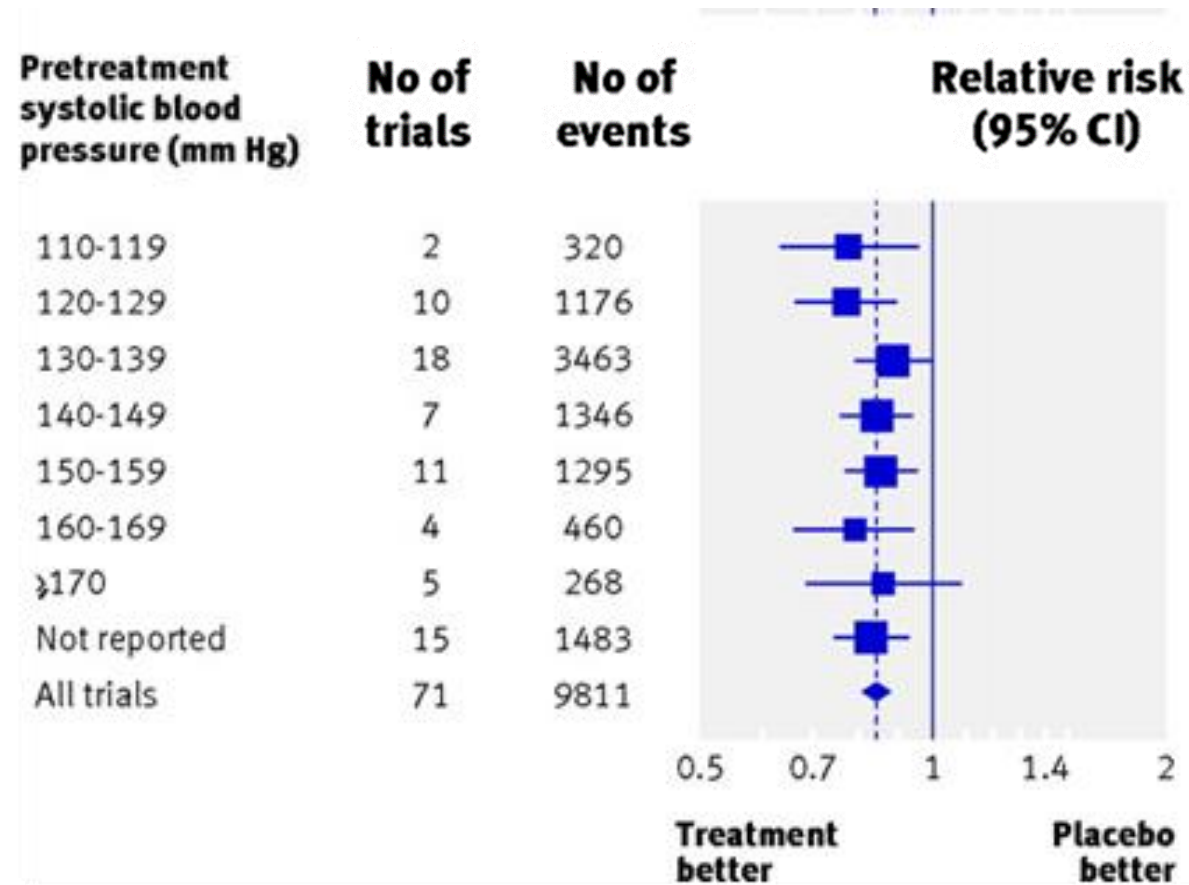
- ARED exercise 6 days/week
- 10 gm NaCl prior to descent
- 1 – 1.5 L water prior to descent
- Spandex custom compression hose
- Cool air
- Midodrine (not with interfering drugs)

Postural orthostatic tachycardia syndrome

POTS

- Heart rate response to low volume or vasodilation
- Requires normal autonomic nerve function
- Most common in women with estrogen
- Responds to exercise, volume and beta blockers

Decrease in relative risk for coronary heart disease per 5 mmHg decrease in treated BP. The relative risk fall was the same in low through high baseline BP groups.



Law MR. Blood pressure-lowering treatment should be based on the level of cardiovascular risk, not on the level of blood pressure. Evid Based Med. 2015 Feb;20(1):21. doi: 10.1136/ebmed-2014-110102. Epub 2014 Dec 22. PMID: 25534965.

5 mm Hg relative reduction in CV events by baseline BP in 48 randomized trials of BP lowering

BP lowering trialists collaboration Lancet 2021

Previous cardiovascular disease at baseline

	Intervention		Comparator		HR (95% CI)
	Events	Total	Events	Total	
Major cardiovascular events					
<120	562	5506	821	6211	0.77 (0.68–0.87)
120–129	1020	9029	1306	10234	0.89 (0.81–0.98)
130–139	1555	12 887	1835	14 424	0.99 (0.92–1.07)
140–149	1852	15 043	2321	16 938	0.89 (0.83–0.96)
150–159	1606	12 306	2091	14 303	0.90 (0.83–0.97)
160–169	1247	9 626	1555	10 424	0.83 (0.76–0.91)
≥170	1507	9 454	1781	10 063	0.90 (0.83–0.97)
Adjusted $p_{\text{interaction}}$ 0.28					
Unadjusted $p_{\text{interaction}}$ 0.04					
Stroke					
<120	142	5553	209	6263	0.85 (0.66–1.09)
120–129	317	9088	394	10286	0.88 (0.74–1.04)
130–139	546	12 952	591	14 514	1.04 (0.91–1.18)
140–149	670	15 117	836	17 031	0.87 (0.77–0.98)
150–159	562	12 353	801	14 372	0.81 (0.71–0.92)
160–169	530	9 656	614	10 472	0.85 (0.75–0.97)
≥170	634	9 511	721	10 126	0.92 (0.82–1.04)
Adjusted $p_{\text{interaction}}$ 0.42					
Unadjusted $p_{\text{interaction}}$ 0.06					

Reduction in relative risk for CV disease by reduction in SBP

