

Mapping the Failure: A Biomechanical Rationale for V-MAP and the Phenotyping of Stress Urinary Incontinence

V-MAP shifts urethral mobility assessment from measuring how far the urethra moves to identifying how the supporting tissue fails.

Proposed UPD strain thresholds of 25% and 33% define biomechanical zones of tissue competence, plastic deformation, and structural failure, potentially guiding individualized management in SUI.

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V-MAP: moving from descriptive anatomy to biomechanical phenotyping

Dynamic transperineal ultrasound protocol for assessing the functional state of urethral support in SUI

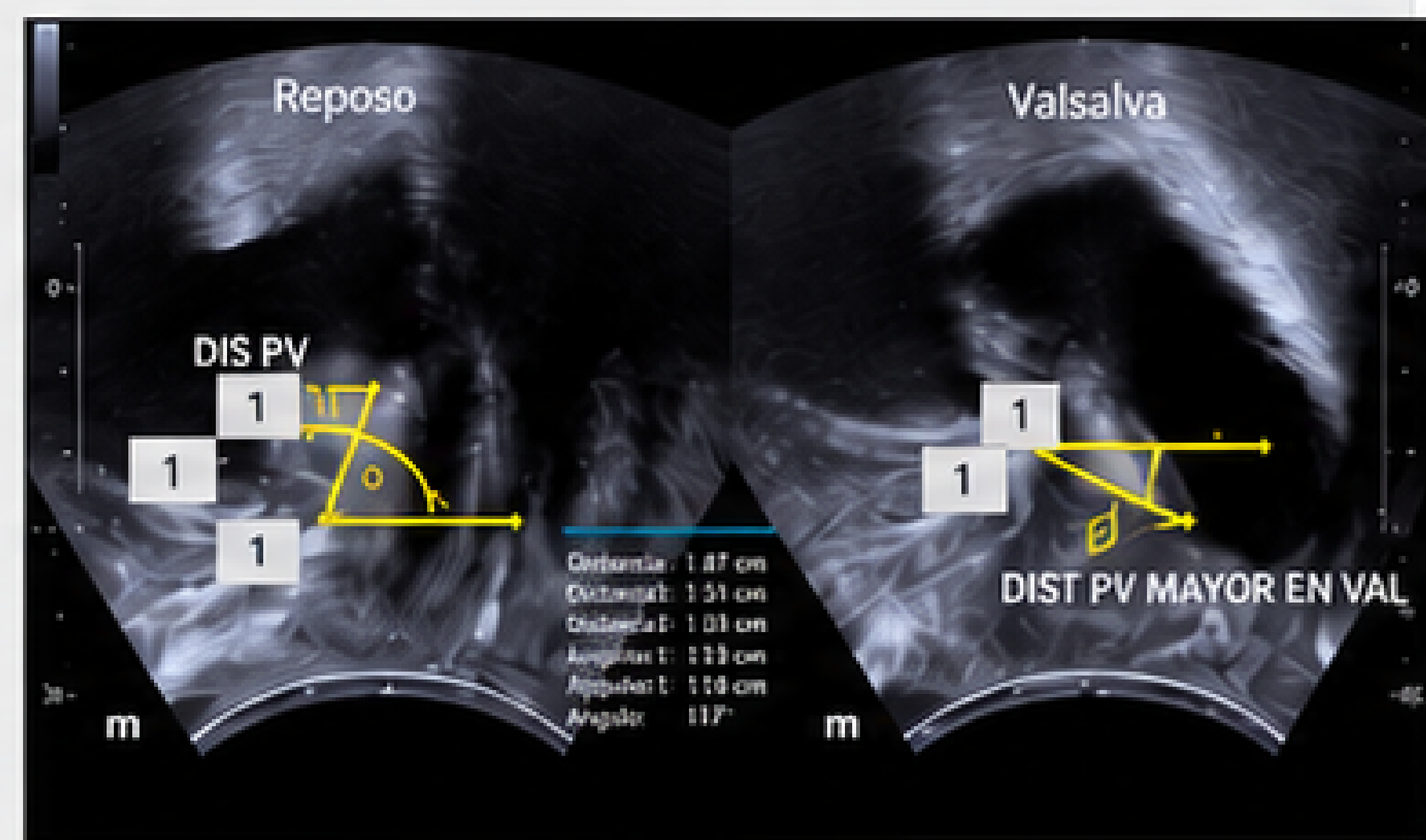
BACKGROUND

Conventional ultrasound SUI metrics—including bladder neck descent (BND), urethral rotation angle (URA), and retrovesical angle (RVA)—describe movement but do not reflect the biomechanical state of urethral support.

V-MAP proposes that SUI reflects sequential vectorial failure of urethral support rather than a single anatomic displacement, integrating dynamic assessment of urethro-pubic distance (UPD) and urethro-pubic angle (UPA).

STUDY AIM

To evaluate V-MAP as a dynamic TPUS protocol that transitions from descriptive anatomy to biomechanical phenotyping based on the functional state of urethral support, assessing UPD and UPA at rest and during maximal Valsalva.



V-MAP PROTOCOL – ORBITAL MOBILITY

REST **VALSALVA**

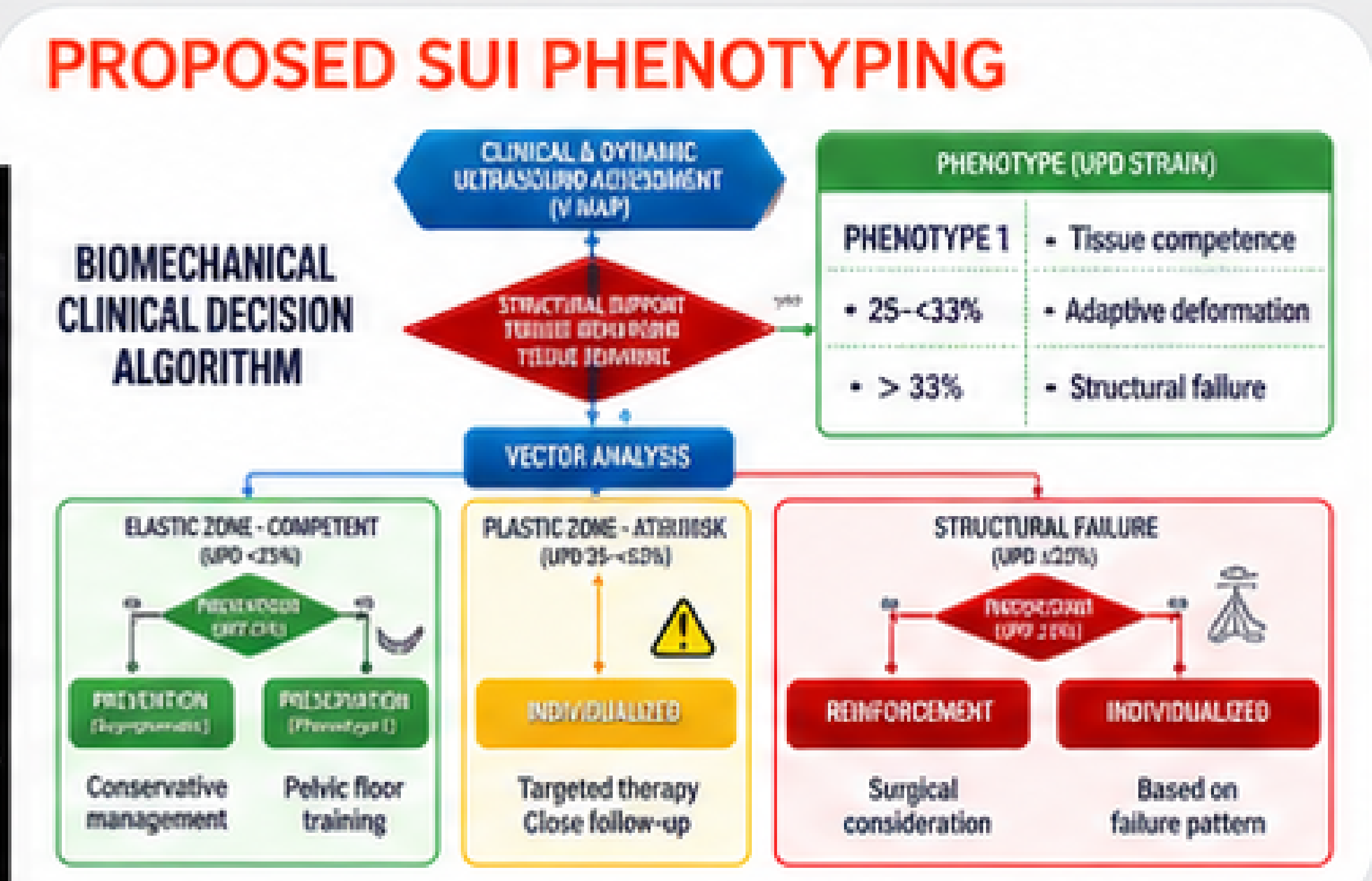
UPD-R UPA-R/T Pubis UPD-V UPA-V/T Valsalva

Bladder Neck Descent

- **UPD:** urethro-pubic distance
- **UPA:** urethro-pubic angle / vectorial displacement during maximal Valsalva
- **UPD strain:** percentage elongation $(UPD_{Valsalva} - UPD_{rest}) / UPD_{rest} \times 100$

PROPOSED UPD BIOMECHANICAL ZONES

Elastic zone <25%	Plastic zone 25–<33%	Structural failure ≥33%
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INTERPRETATION

Urethral mobility reflects tissue distensibility rather than displacement alone. UPD strain suggests a biomechanical continuum:

- **Elastic** (competent tissue): UPD strain <25%
- **Plastic deformation:** UPD strain 25–<33%
- **Structural failure:** UPD strain ≥33%

V-MAP complements conventional mobility metrics by characterizing tissue competence and potential failure patterns.

CONCLUDING MESSAGE

V-MAP proposes SUI as a spectrum of sequential urethral support failure rather than a single anatomic displacement. By clarifying “grey zones” where conventional measurements overlap, it may support biomechanical phenotyping and individualized management according to the detected failure pattern.

LIMITATIONS

Single-center study with a relatively small sample. Proposed biomechanical thresholds require external validation. V-MAP identifies associations with continence status but does not establish causality or treatment outcomes. Prospective studies are needed to confirm reproducibility and clinical utility.