



Laboratoire
Mécanique
Lille



L **BioTim**
M Biomedical soft
Tissue
L Modelling research group

Simulation biomécanique chirurgie prothétique des cystocèles :

Promontofixation et voie basse

Géry LAMBLIN, Olivier MAYEUR, Estelle Jean dit Gautier
Géraldine GIRAUDET, Chrystèle RUBOD,
Mathias BRIEU, Michel COSSON



Université
de Lille
1 SCIENCES
ET TECHNOLOGIES

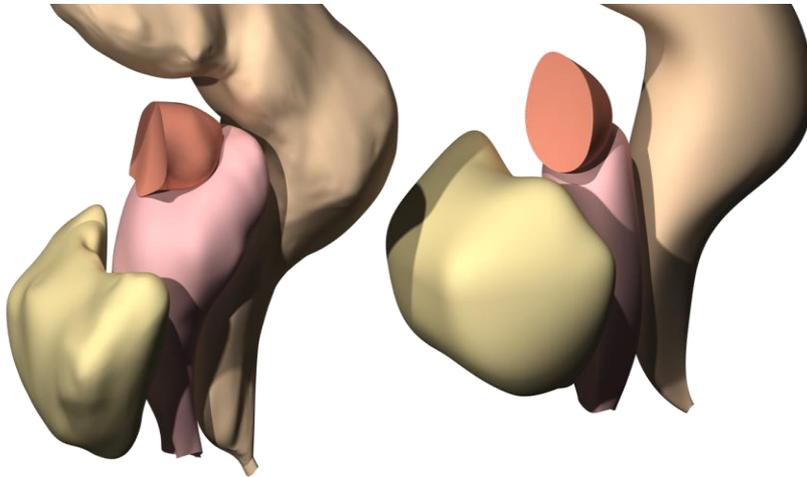


ARTS
ET MÉTIERS
ParisTech

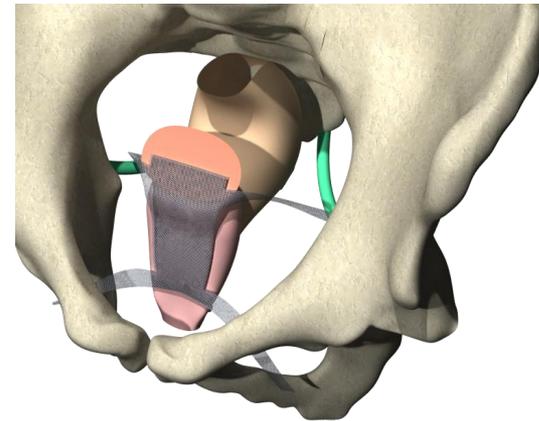


Modèle générique biomécanique- Applications ?

Modélisation cystocèle
médiane, latérale, apicale



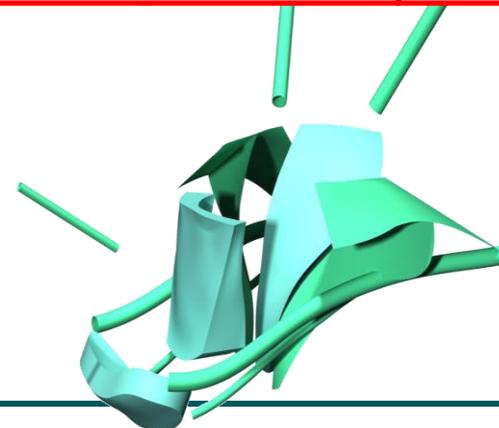
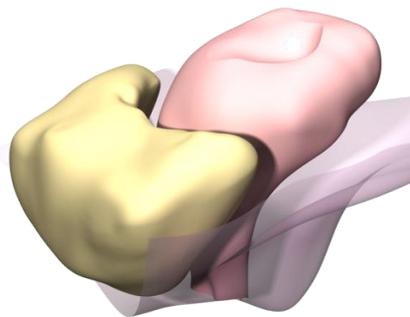
Simulations corrections
chirurgicales cystocèle



vessie : possibilité de vider vessie ou non
Vagin avec contenu pour améliorer le contraste
Modifier latéralisation de utérus - modèle personnalisé

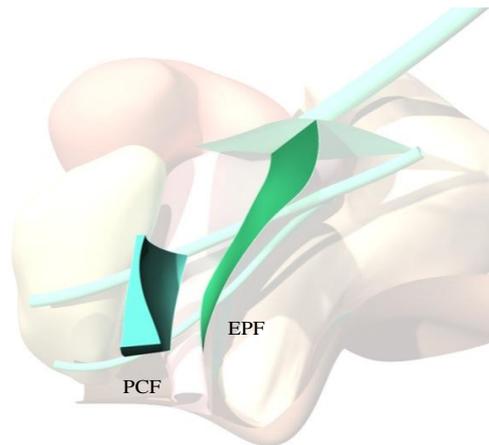
A1. Modélisation cystocèle médiane, latérale et apicale

	Medial cystocele		Apical cystocele		Lateral cystocele	
anatomic structures	PCF	Endopelvic fascia	Cervical ring	Uterosacral ligament	ATFP	ATLA
Petros	+	-	+	-	+	-
Delancey	+	+	+	+	+	+

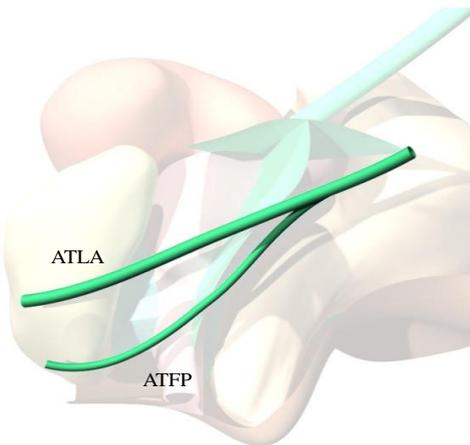


Modélisation cystocèle médiane et latérale

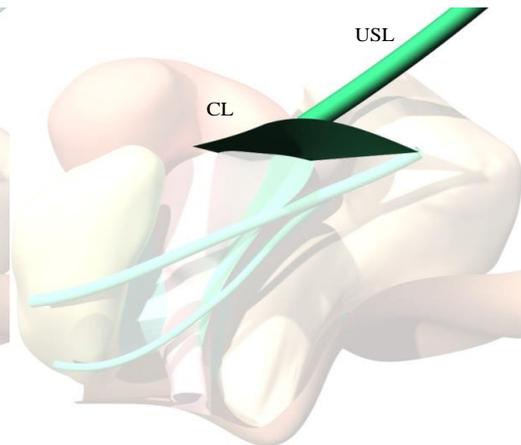
Objectif: pilotage des structures environnantes autour de la vessie



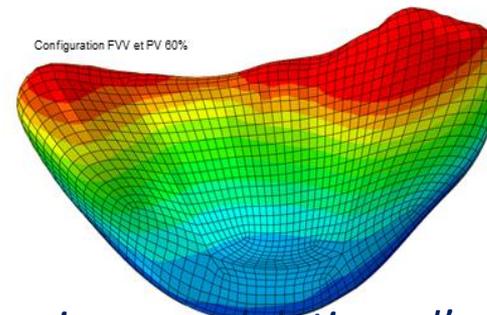
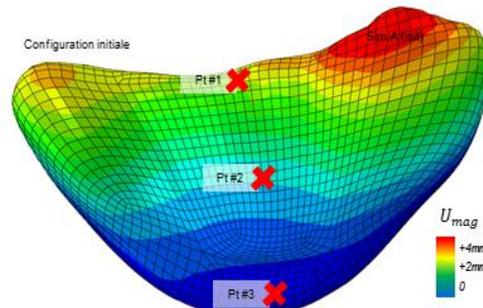
médiane



latérale



apicale

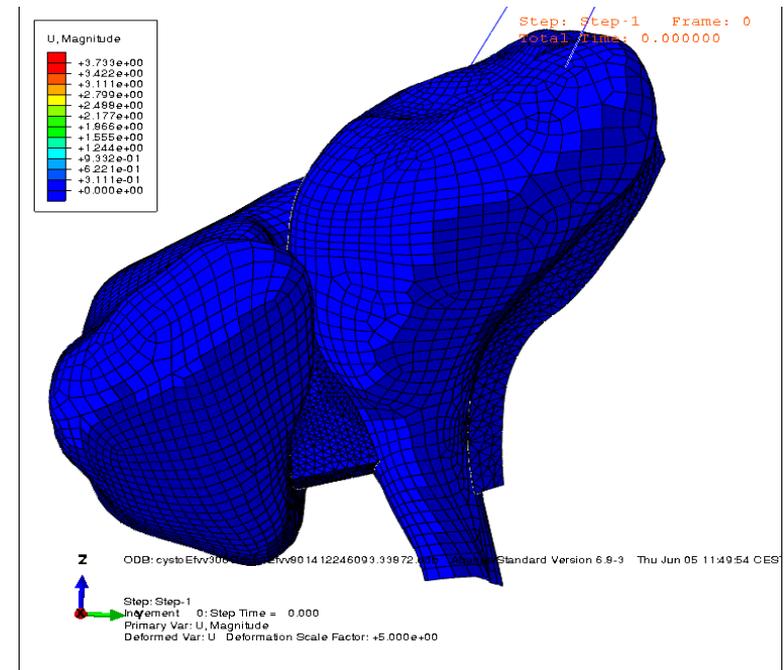
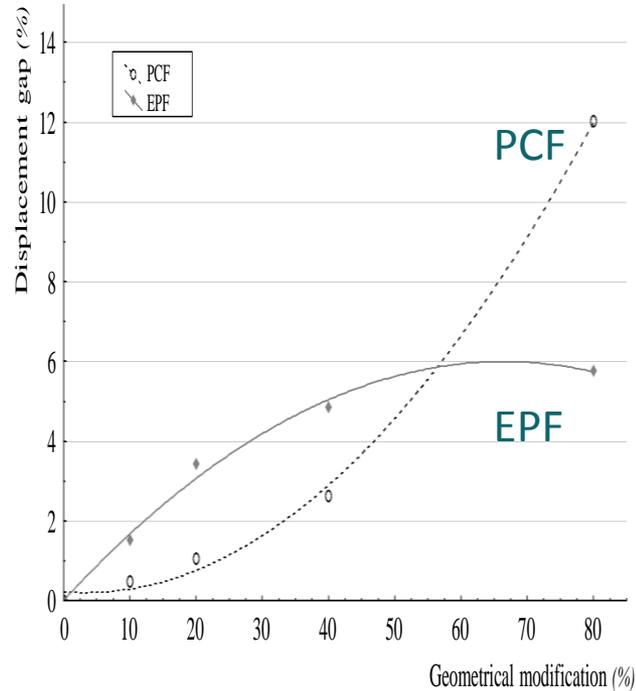


déplacements de la vessie en modulations d'amplitude U avec des iso valeurs



Simulation cystocèle médiane

Fascia pubo cervical = cystocèle médiane

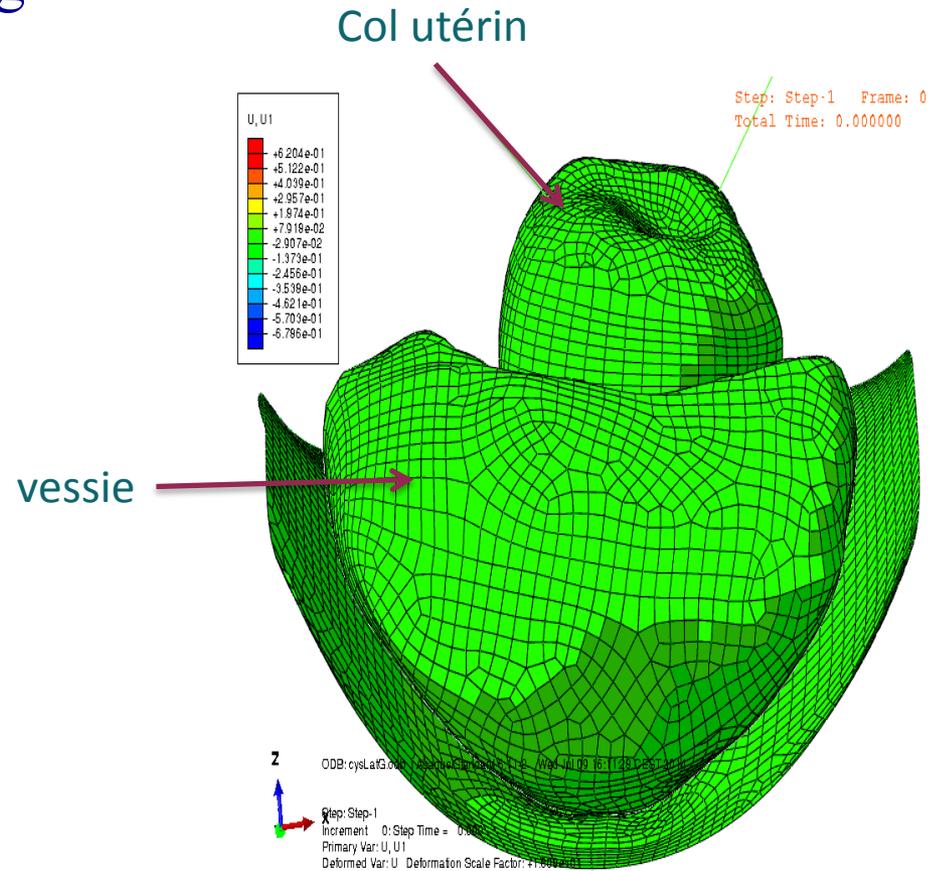
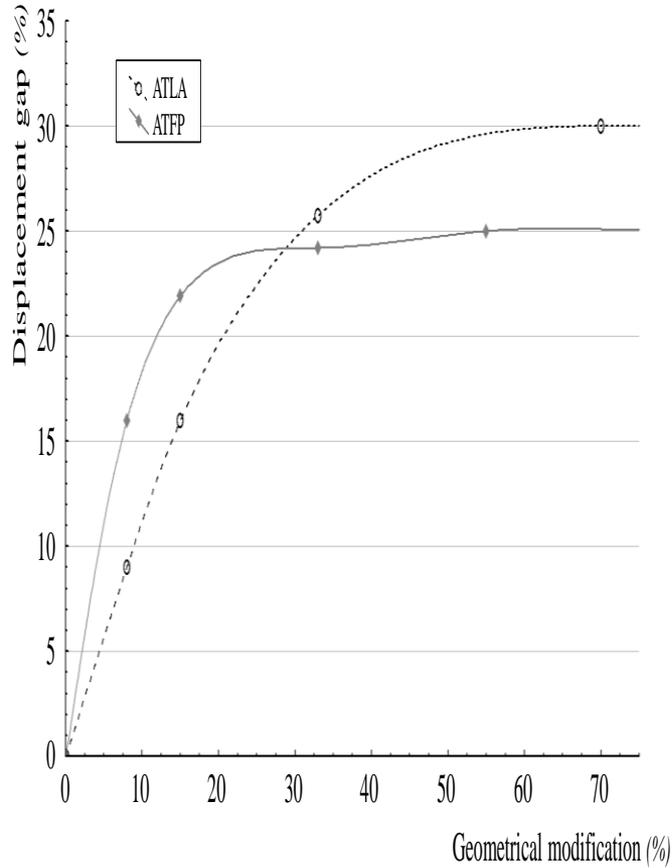


Fascia pubo cervical amplitude forte après une dégradation de 60%



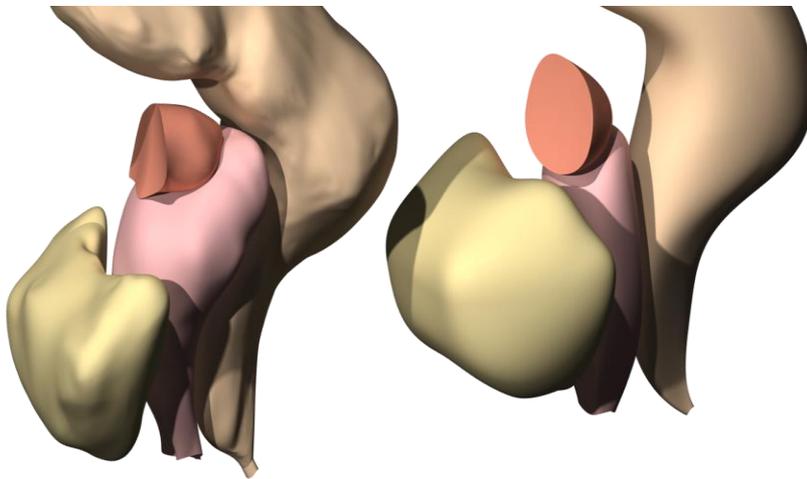
Simulation cystocèle latérale

Modifications ATLA et ATPF = modification du plancher
↗ 15% de la mobilité du vagin

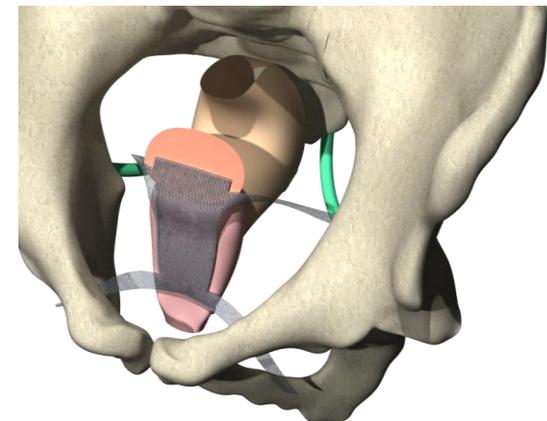


2. Applications modèle générique biomécanique du pelvis

Modélisation cystocèle
médiante et latérale



Simulations corrections chirurgicales
cystocèle



Recommandations actuelles CNGOF/AFU

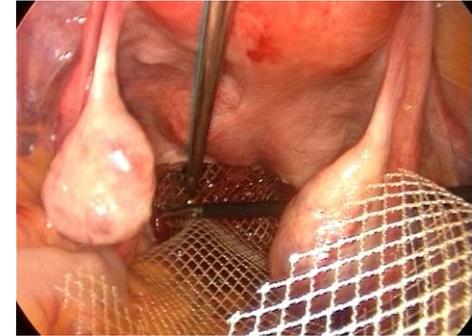


Promontofixation

Prothèse polypropylène ou polyester non enduit
(grade C)

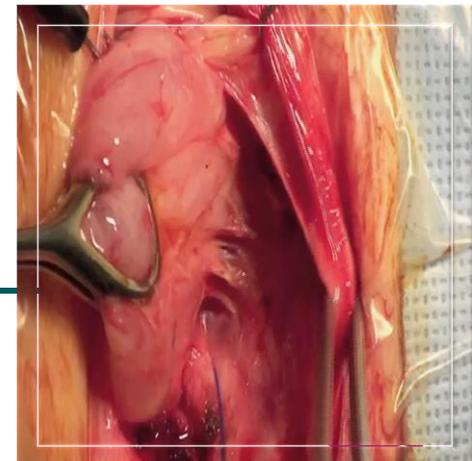
Fixation:

- Vaginal : dispositif non transfixiant (AE)
- col/isthme utérin: fils ou système agrafage automatique (AE)



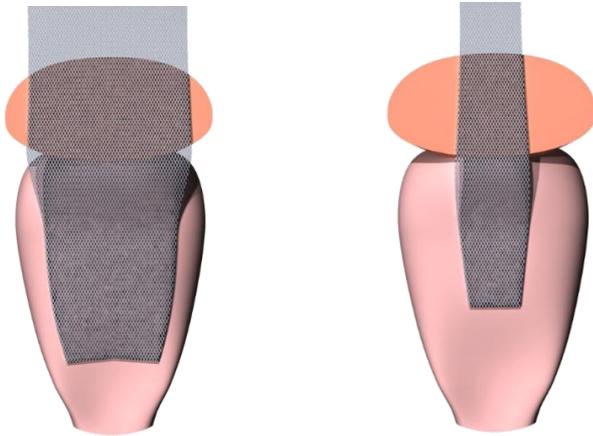
Voie vaginale

Polypropylène monofilament tricoté à larges pores
(macroporeux) grade B



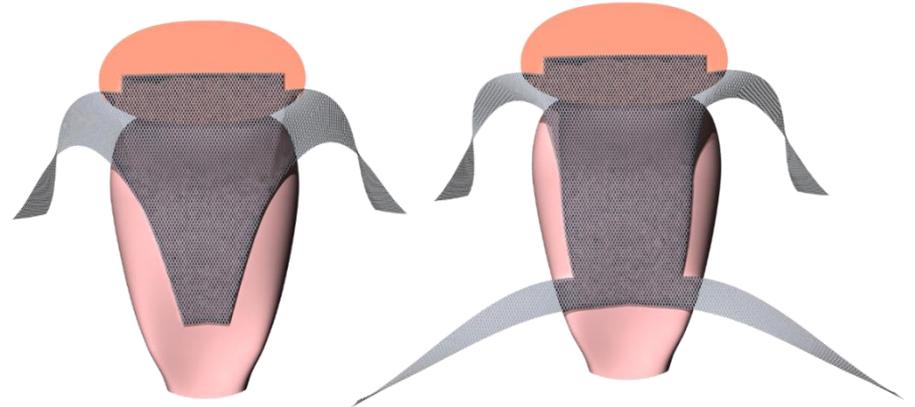
Points techniques non résolus

Promontofixation



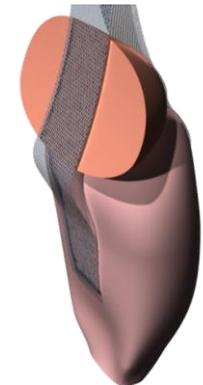
Taille et surface des prothèses ?
Nombre de fixation ?
Ant ou Post ou combinée ?
Espaces entre les points ?

Prothèse vaginale



Taille prothèse ?
kits prothèse Ant \pm postérieure ?

Simulation biomécanique promontofixation



■ Configuration 1: Antérieure

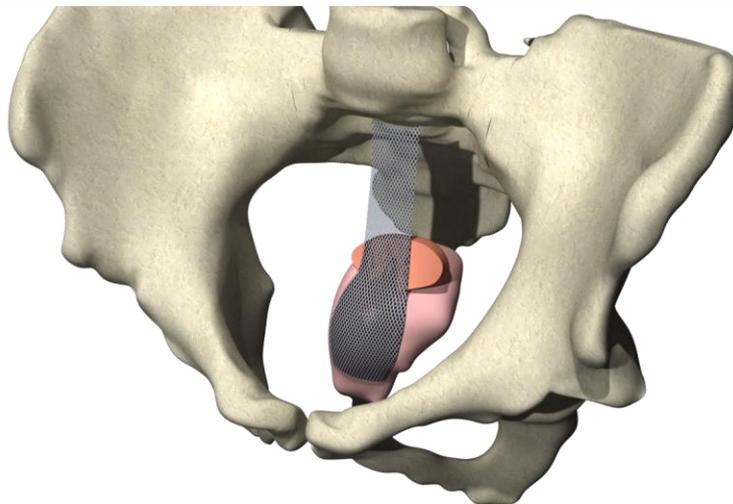
large ou petite prothèse

■ Configuration 2: Postérieure

large ou petite prothèse

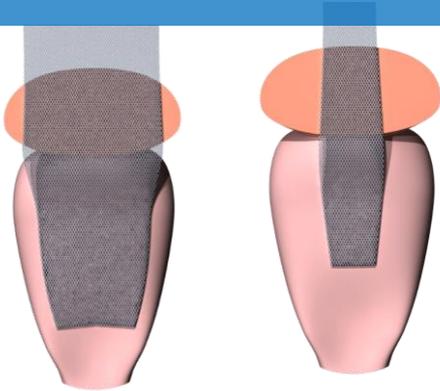
■ Configuration 3: 2 prothèses

Large et petite



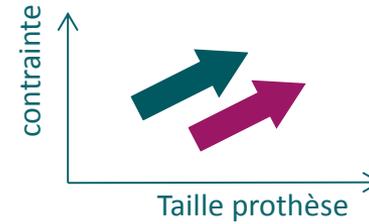
Analyse mobilité vaginale
Analyse de la contrainte sur chaque
structure (MPa)

1. Promontofixation: taille de la prothèse

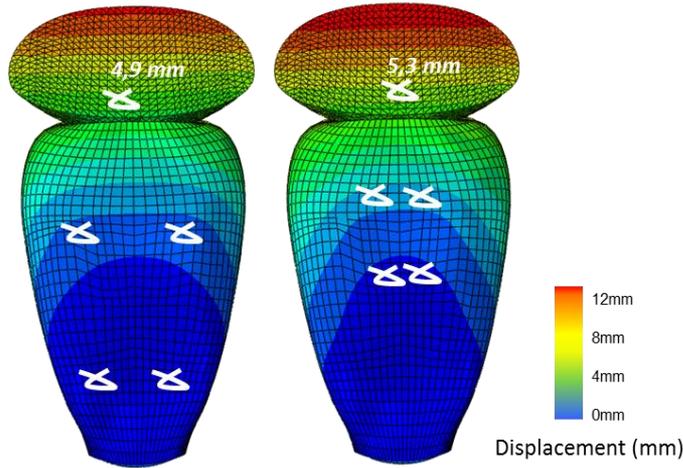


Step #1

Comparison mobilité vaginale

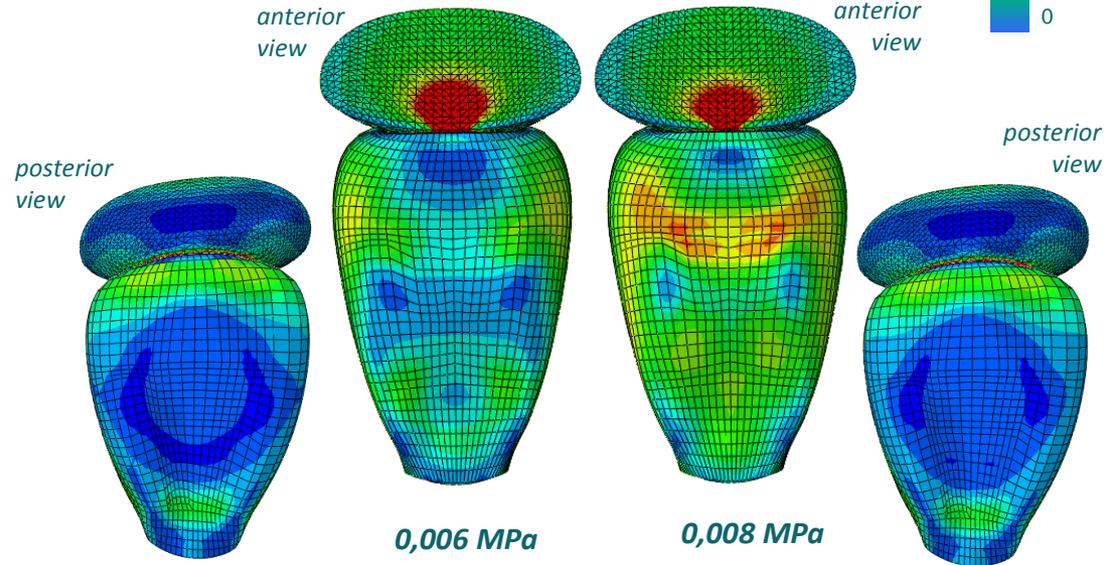


■ Patient-specific model
■ Generic Model

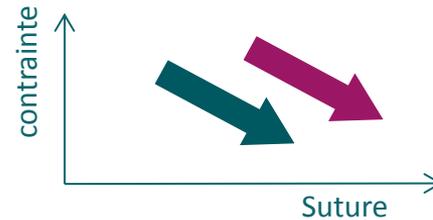
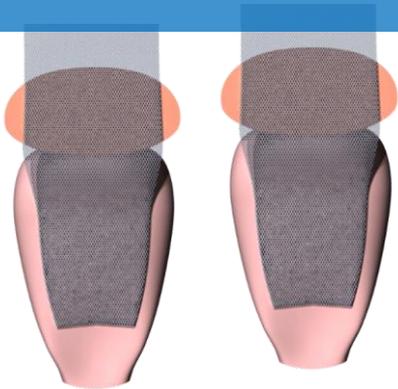


Step #2

Analyse de la contrainte

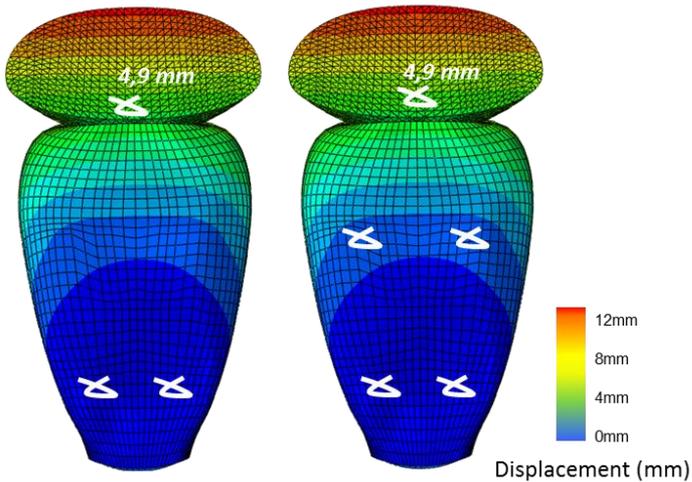


2. Promontofixation: nombre de sutures

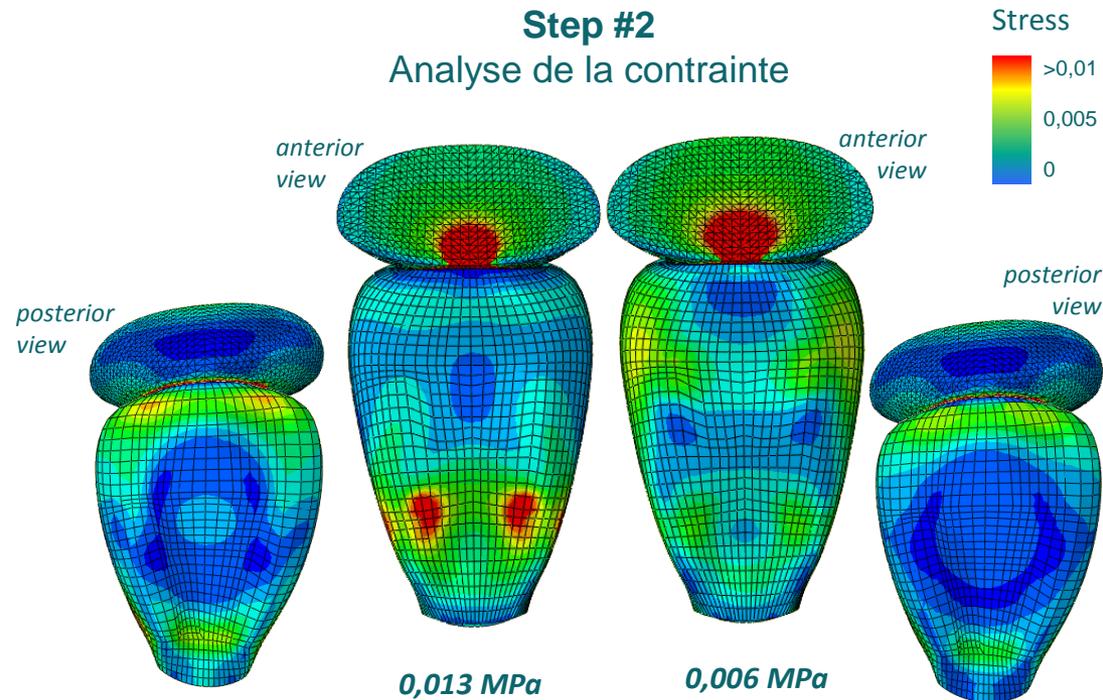


■ Patient-specific model
■ Generic Model

Step #1
Comparaison mobilité vaginale

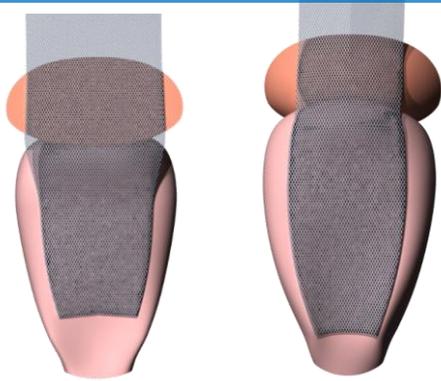


Step #2
Analyse de la contrainte



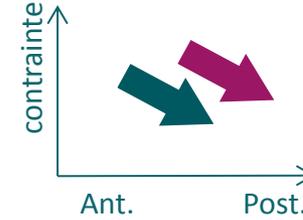
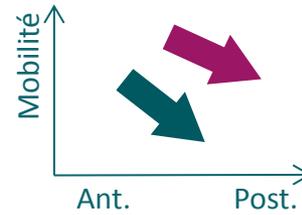
Meilleure répartition des forces

3. Promontofixation : antérieure ou postérieure

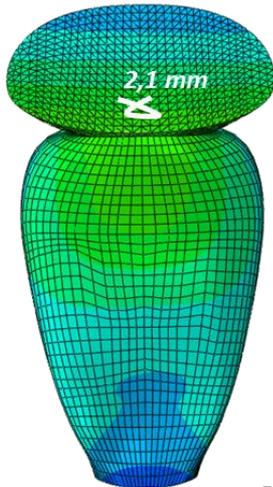
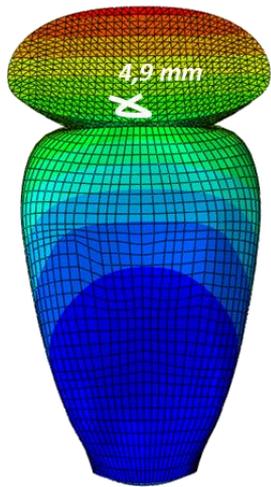


Step #1

Comparison of pelvic organ mobility



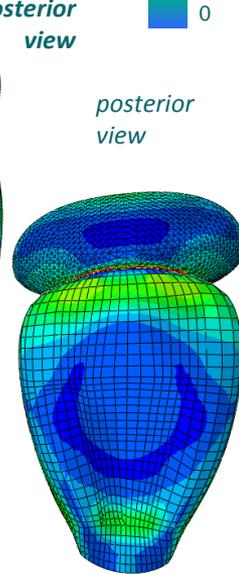
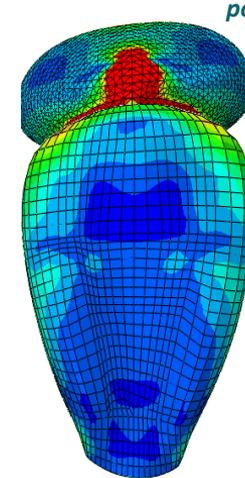
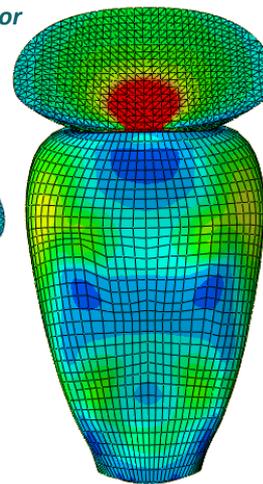
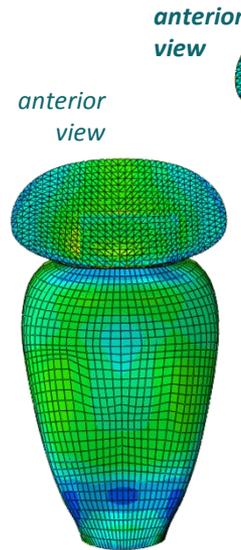
■ Patient-specific model
■ Generic Model



12mm
8mm
4mm
0mm
Displacement (mm)

Step #2

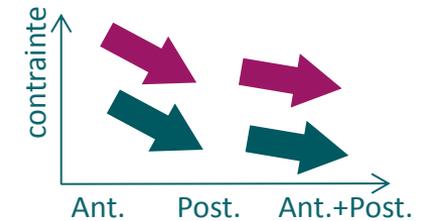
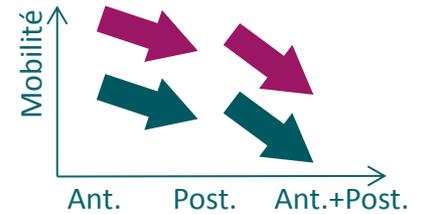
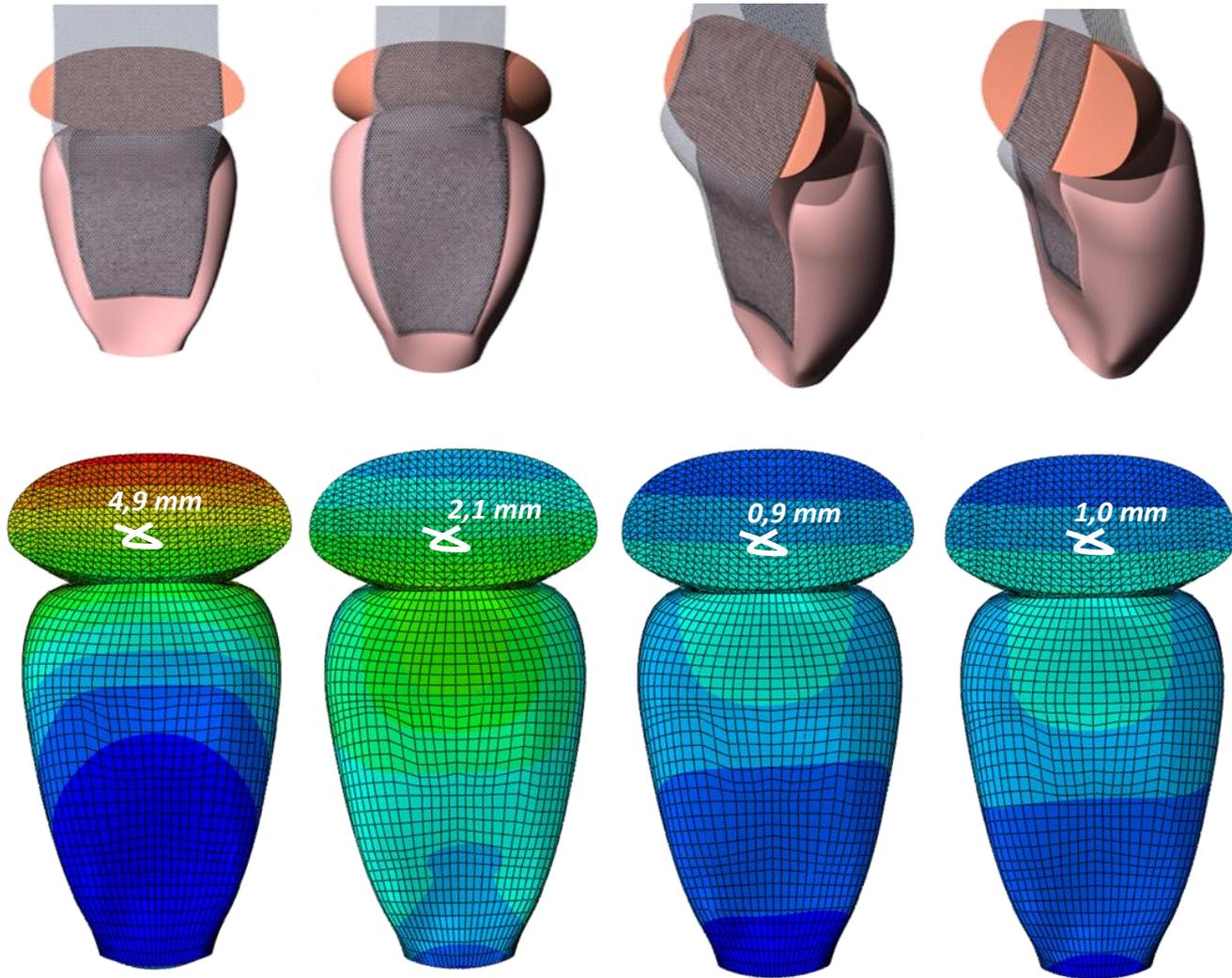
Analysis of suture stress



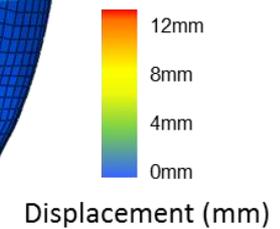
Stress
>0,01
0,005
0

0,008 MPa

4. Promontofixation : 2 prothèses Ant et Post combinés ?

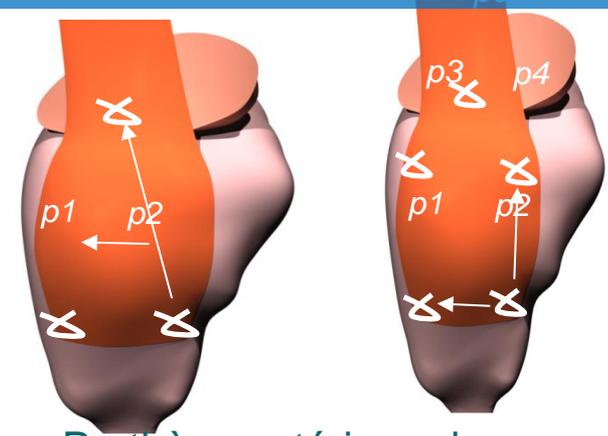


■ Patient-specific model
■ Generic Model

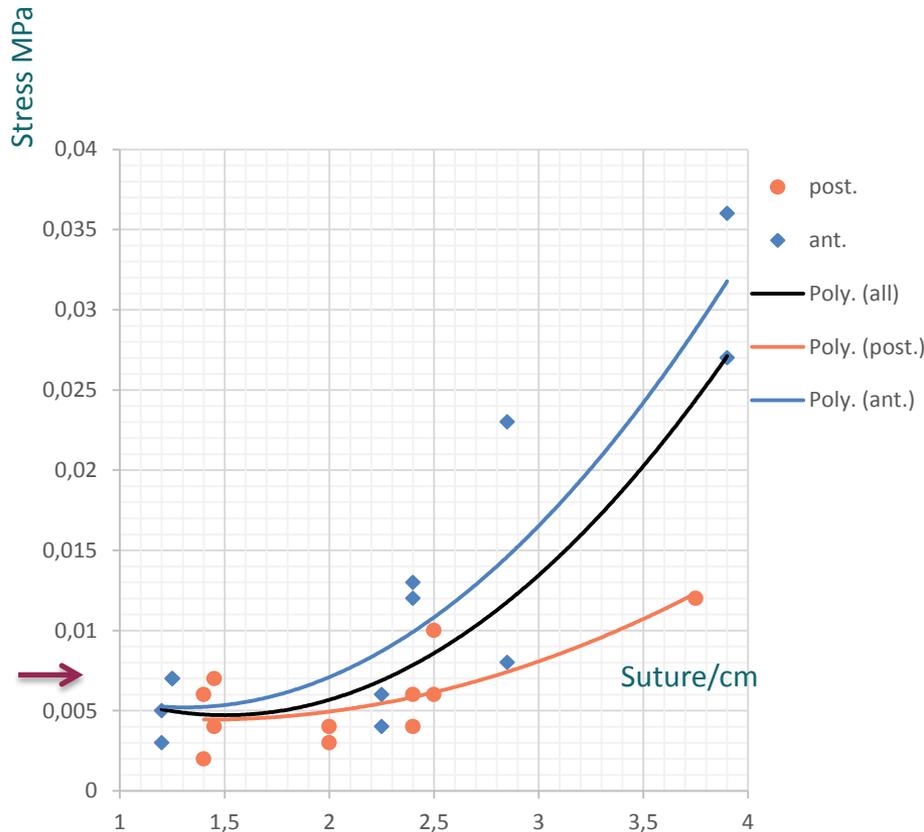


5. Promontofixation : espaces entre sutures vaginales ?

analyse de la contrainte sur suture



Prothèse antérieure large espaces entre les sutures



Conclusion

1 suture toutes les 2.5 cm...

- 1sut 1,5 cm > contrainte 0,005 MPa
- 1sut 2,5 cm > contrainte 0,010 MPa x2
- 1sut 3,5 cm > contrainte 0,025 MPa x5

Anterior : blue line : points rapprochés

Posterior : red line : points plus distaux

Simulation chirurgie prothétique vaginale

ELEVATE™ (AMS)

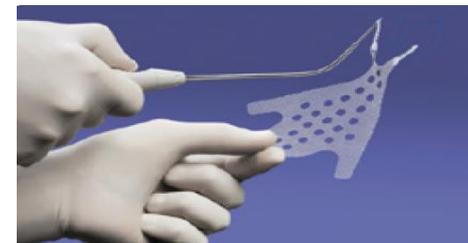
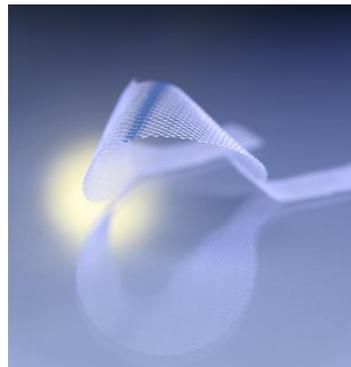
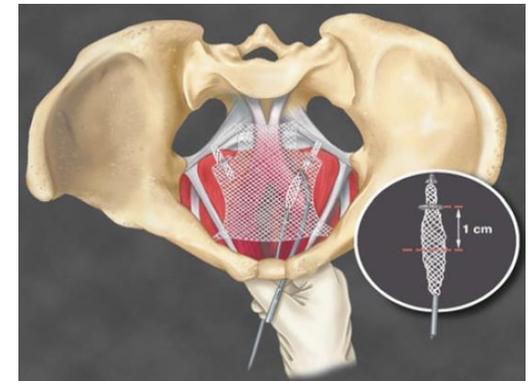
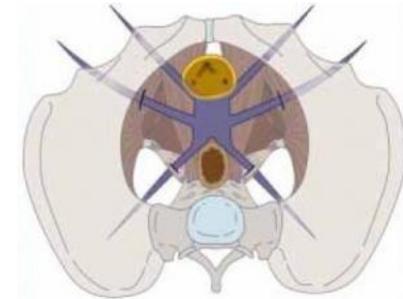
UPHOLD™ (Boston Scientific)

PINNACLE™ (Boston Scientific)

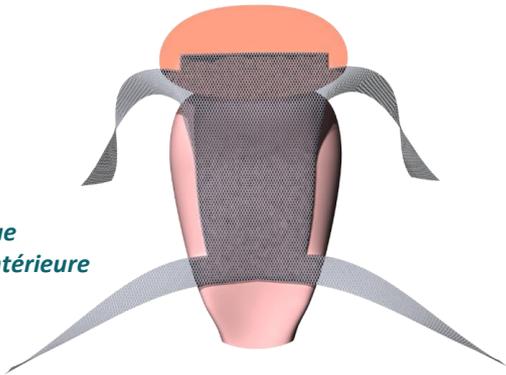
OPUR™ (ABISS)

CALISTAR™ (Promedon)

RESTORELLE™ (Coloplast)



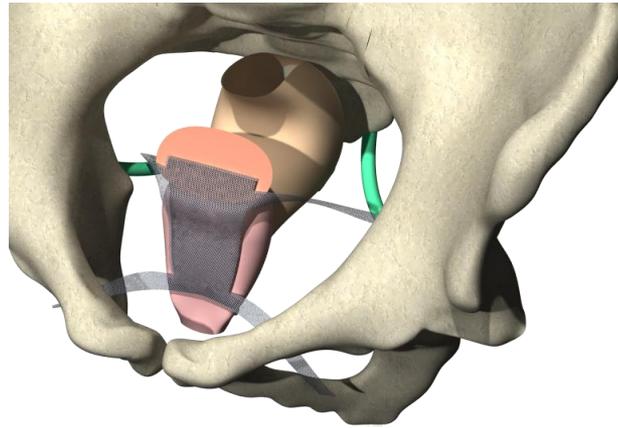
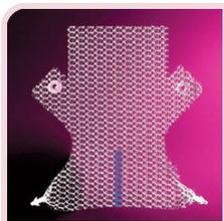
Prothèses vaginales / kits antérieur et postérieur



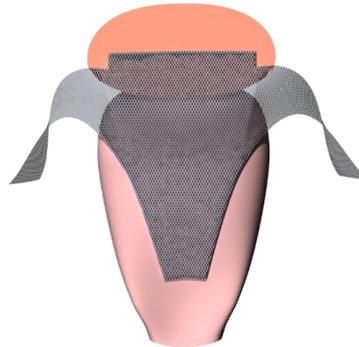
*Vue
antérieure*

1. Configuration

Elevate anterior mesh

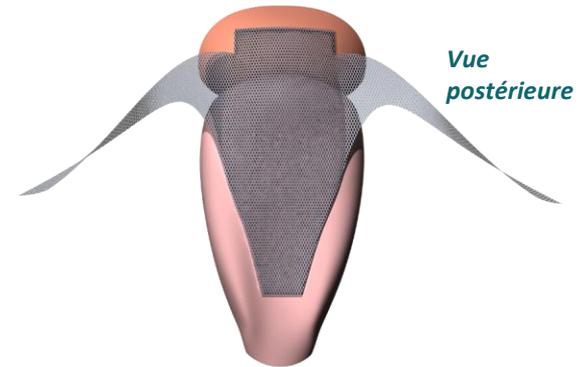
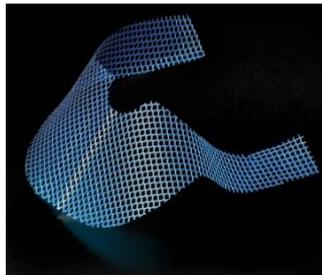


*Vue
antérieure*



2. Configuration

Uphold anterior mesh



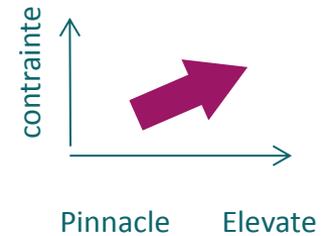
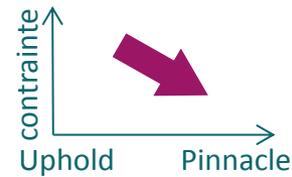
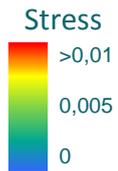
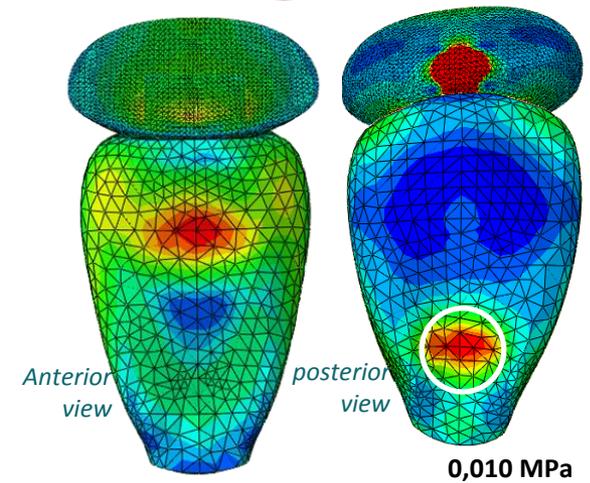
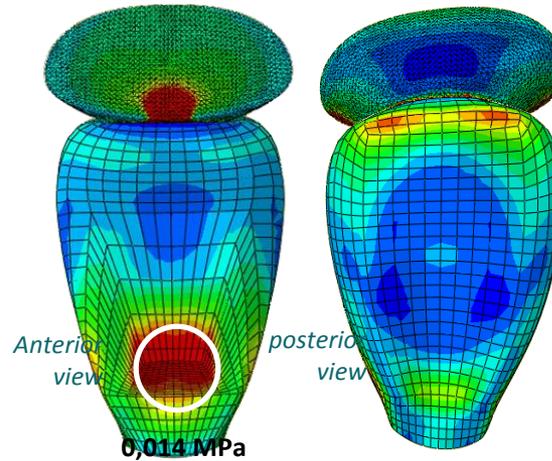
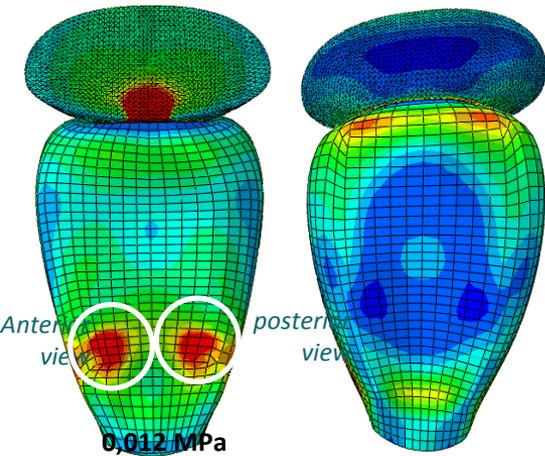
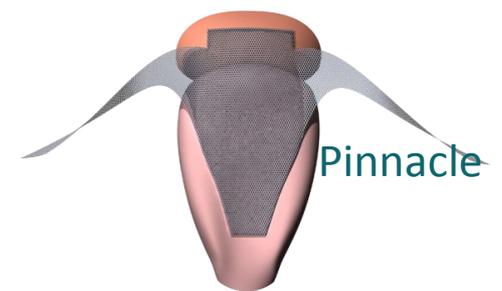
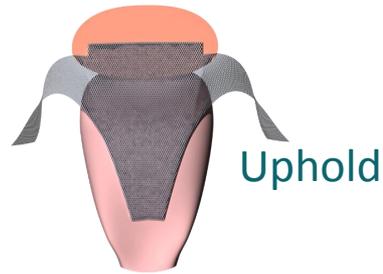
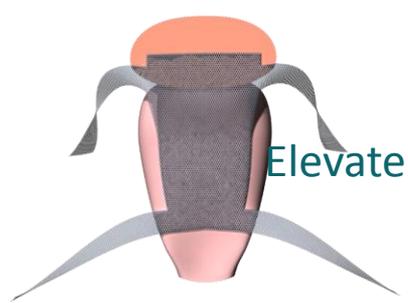
*Vue
postérieure*

3. Configuration

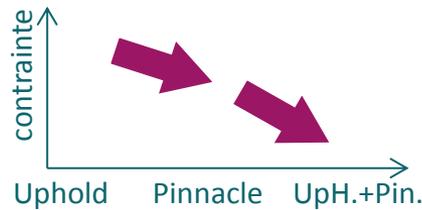
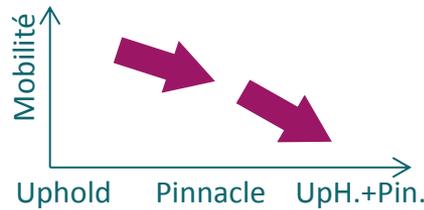
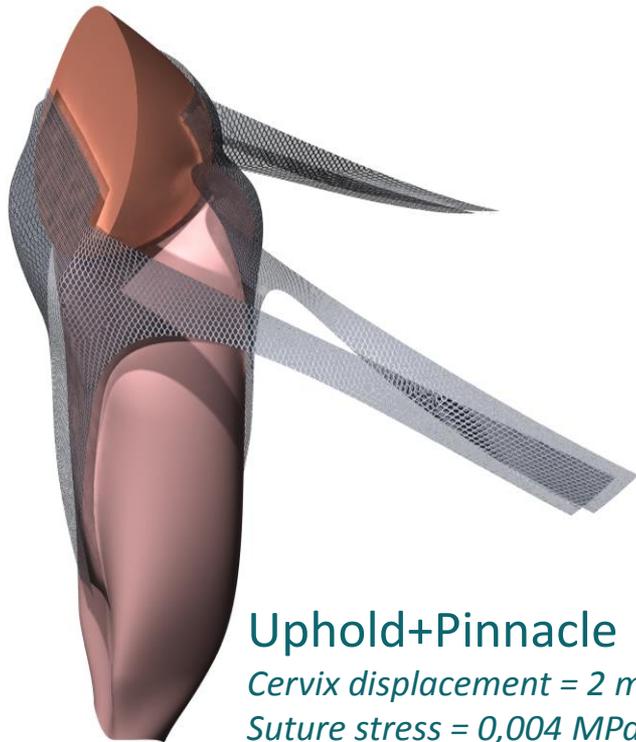
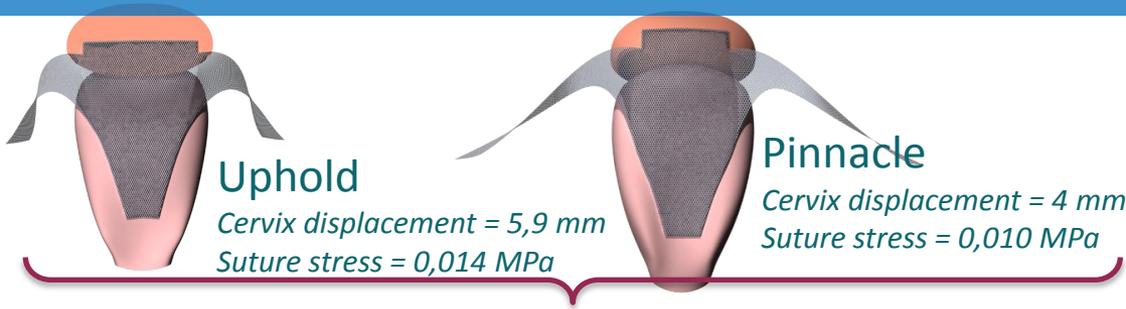
Pinnacle posterior mesh



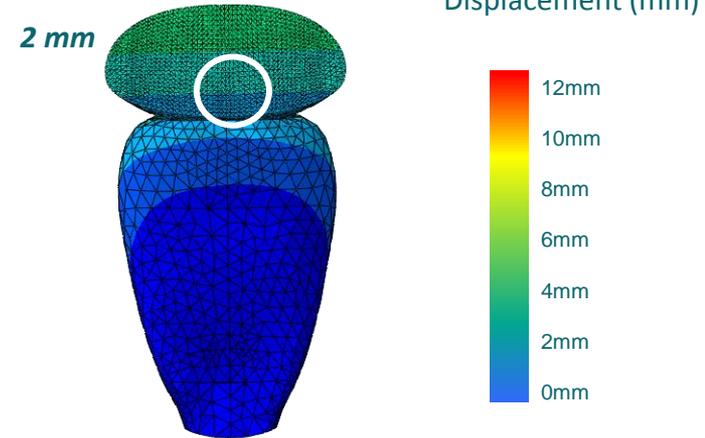
Prothèses vaginales / kits antérieur et postérieur



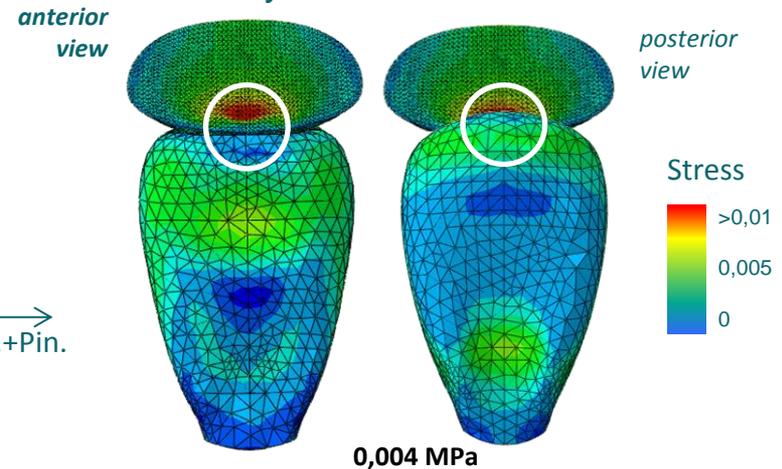
Prothèses vaginales : associer kits antérieurs et postérieur ?



Step #1 Comparison of pelvic organ mobility



Step #2 Analysis of suture stress

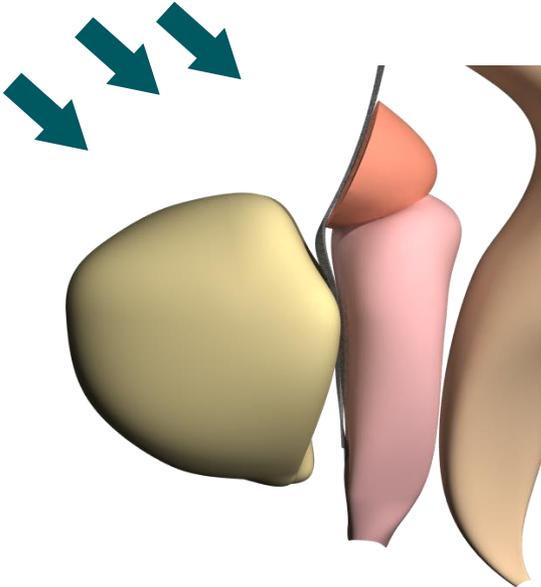


Modèle générique biomécanique du pelvis

Pression

Modifications des conditions de charge

Exemple:
toux = pression à 10-3 MPa
45 degree orientation
[Kamina2008]



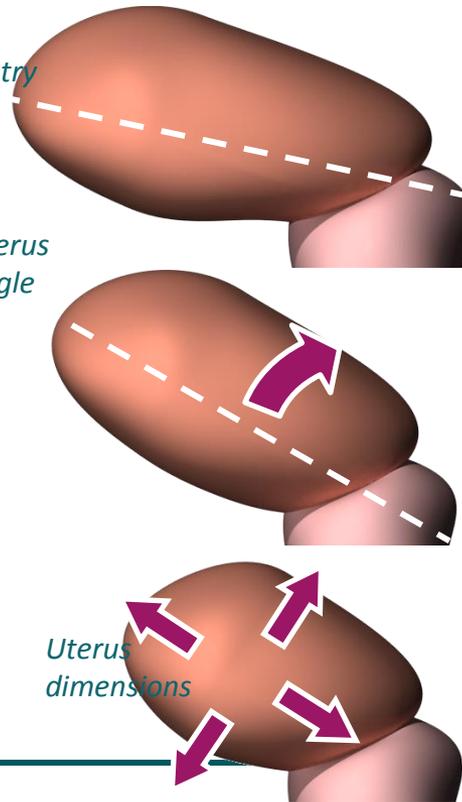
Géométrie

Modèle paramétrique du pelvis

Initial geometry

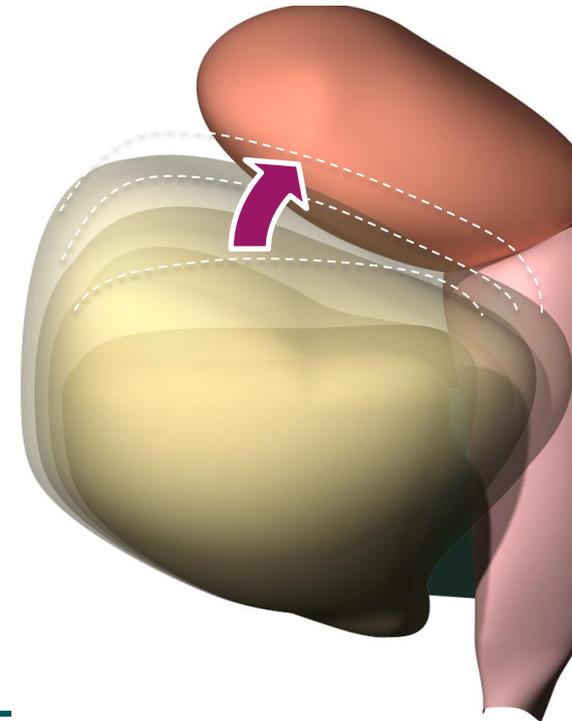
Uterus angle

Uterus dimensions



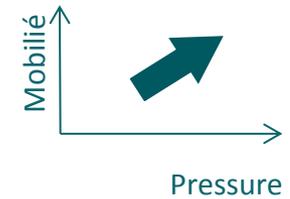
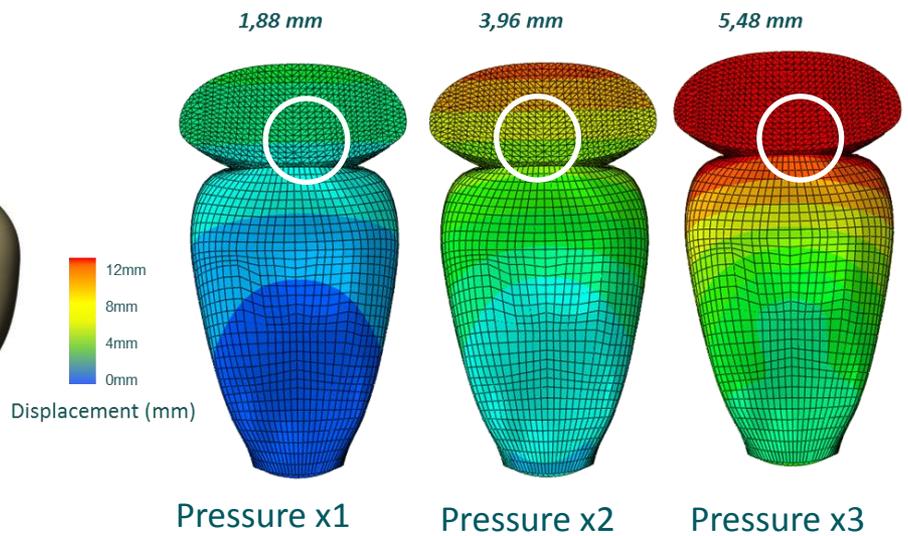
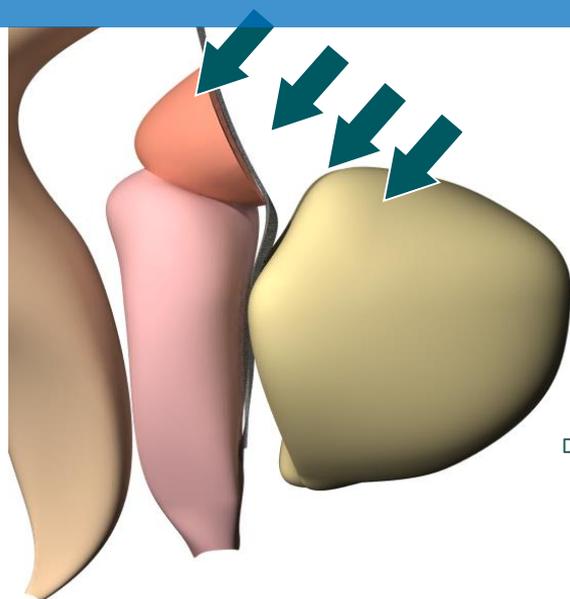
volume vessie

Influence de la vessie sur la mobilité des organes

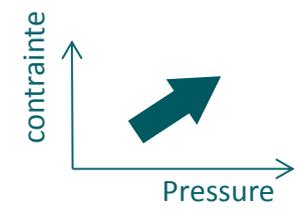
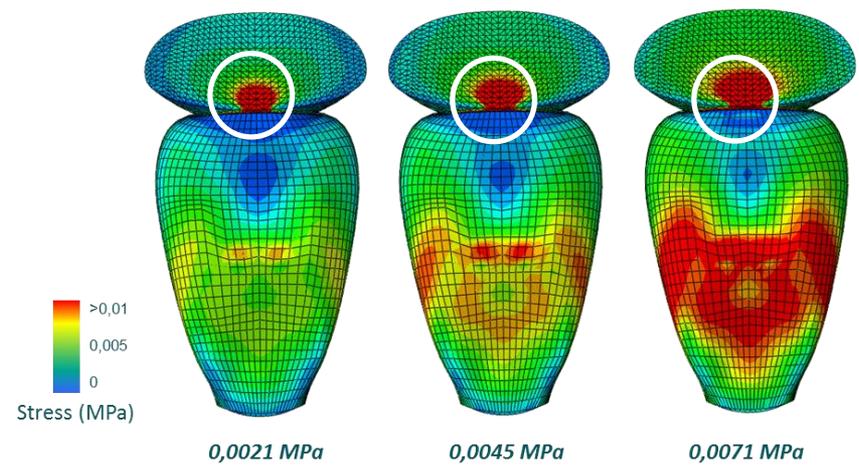
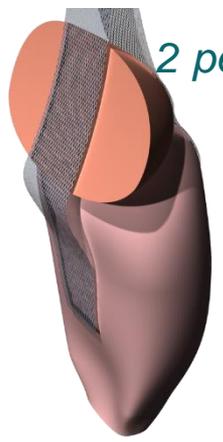


Changement conditions physiologiques après chirurgie

Pression locale



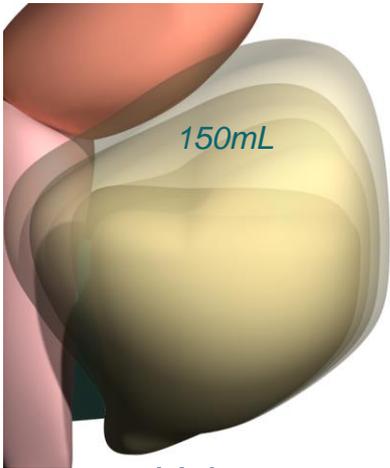
variations de pression
+
2 petites prothèses



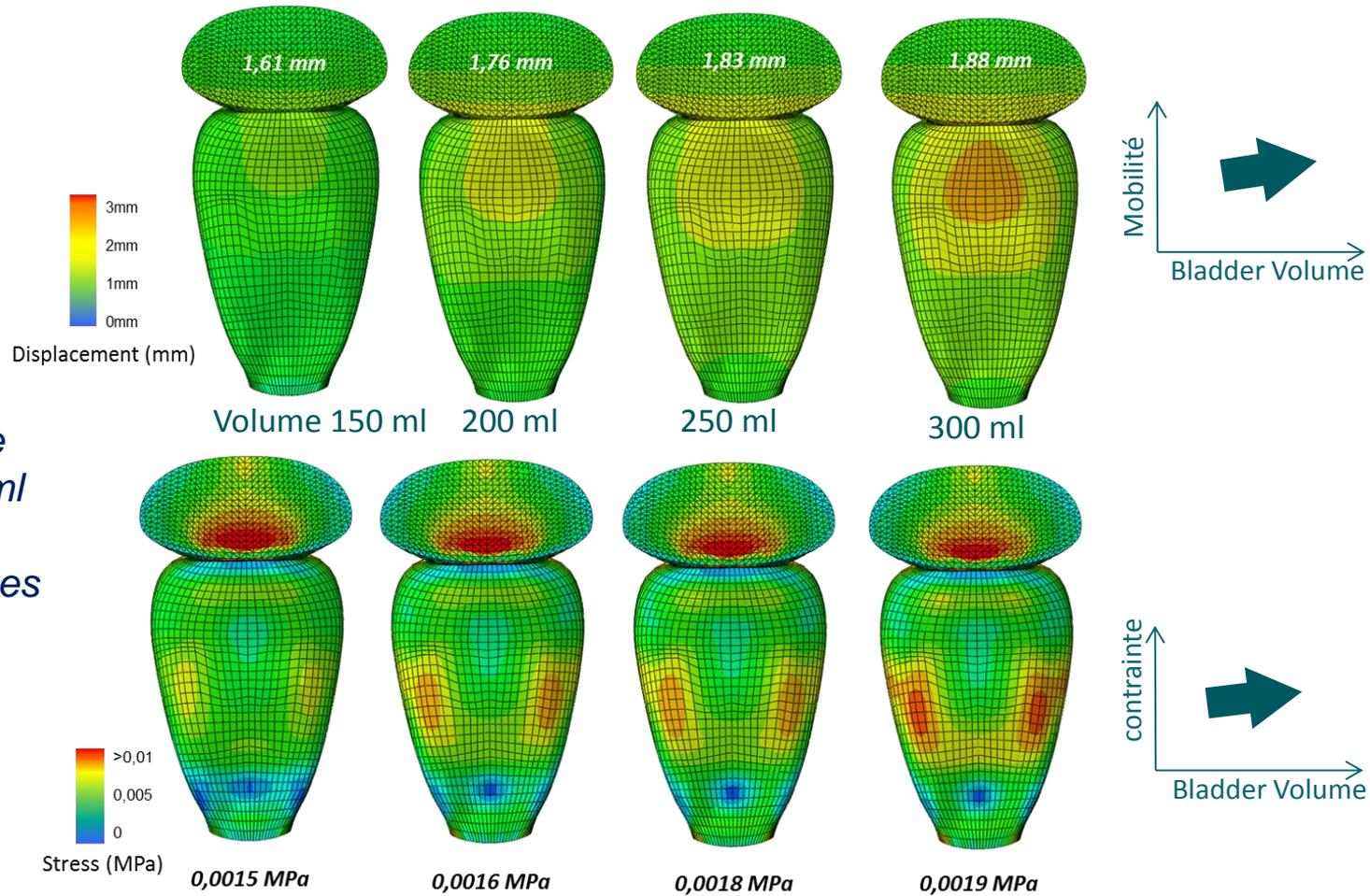
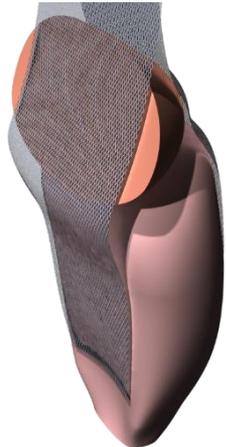
Changement conditions physiologiques après chirurgie

Volume de la vessie

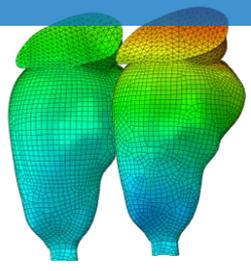
300mL



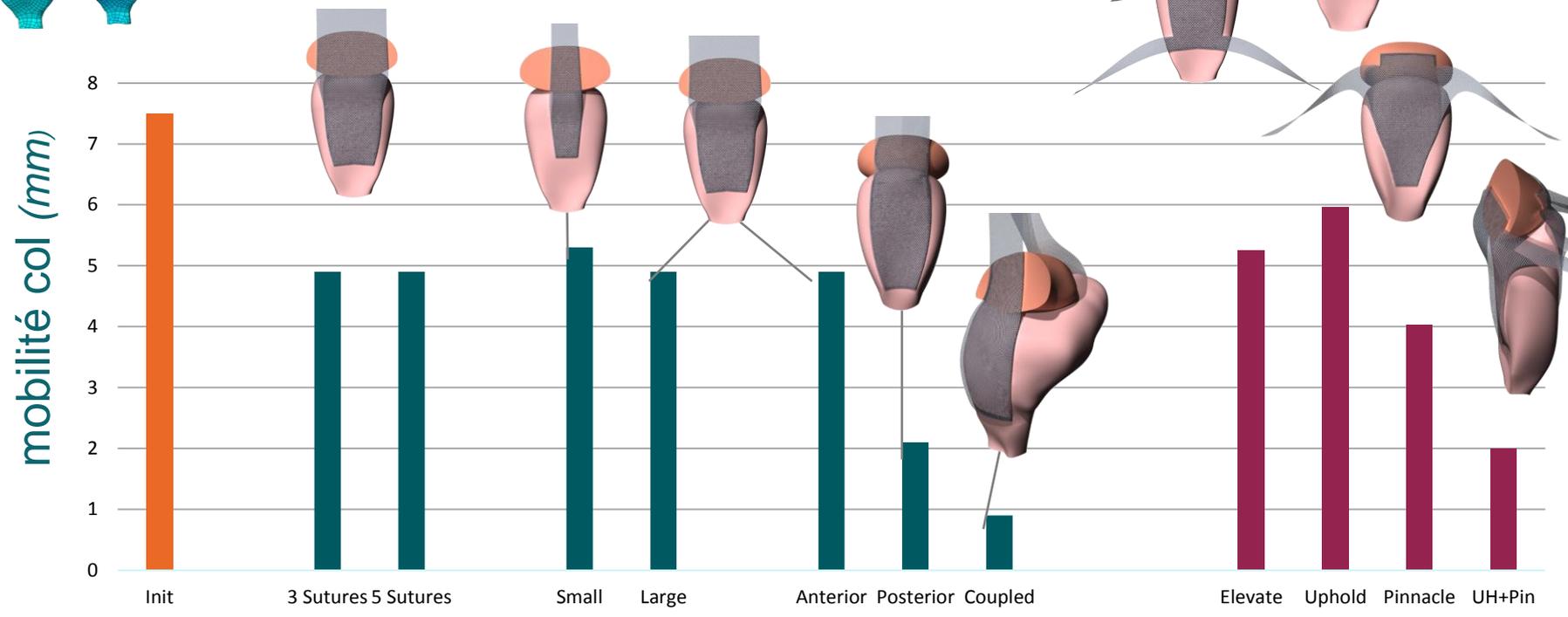
Volume vessie
150 ml to 300 ml
+
2 prothèses larges



Comparaison des différentes prothèses : mobilité



Step #1
Comparison of pelvic organ mobility



NO MESH

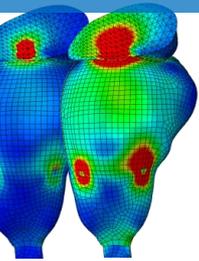
PROMONTOFIXATION

PROTHESE VAGINALE

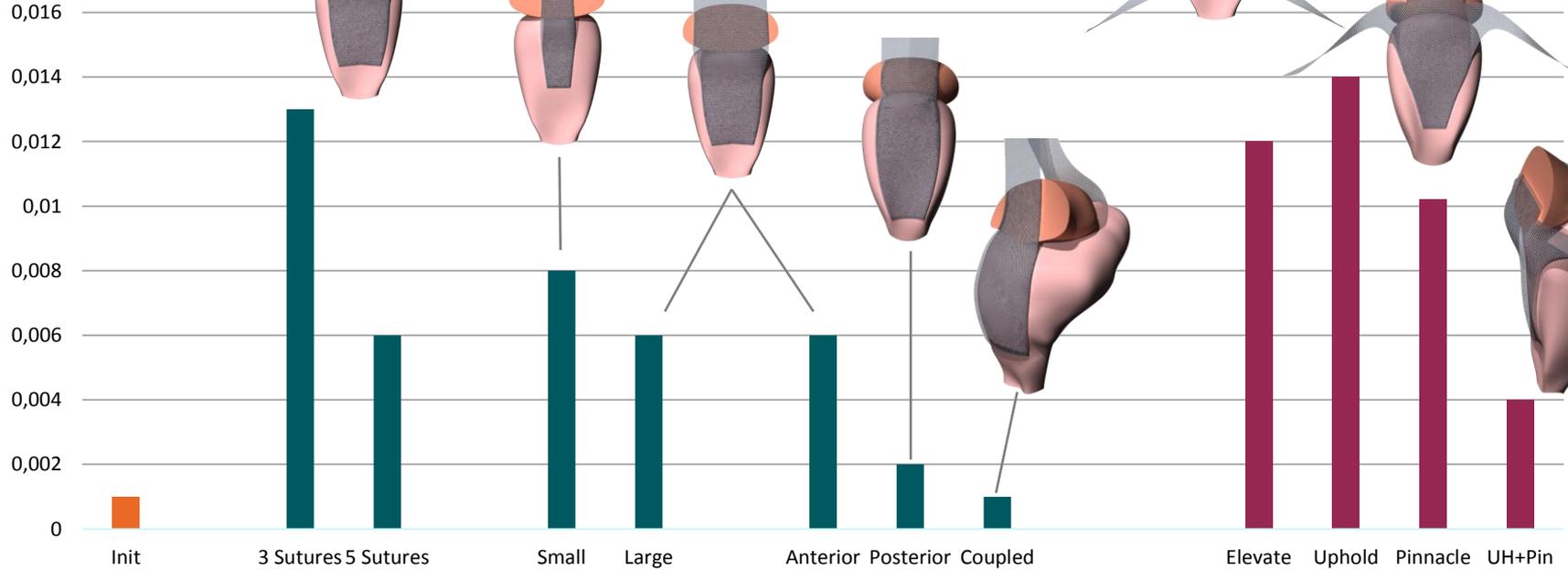
Comparaison des différentes prothèses: contrainte

Step #2

Analysis of suture stress



Contraite (MPa)



NO
MESH

PROMONTOFIXATION

PROTHESE VAGINALE

Conclusion – Simulation biomécanique

Informations originales et intéressantes

- Large prothèse meilleure (- mobilité, + contrainte)
- Promontofixation / espace sutures : Antérieure: 2 cm
Postérieure: 3 cm
- 2 prothèses : meilleure (- mobilité - contrainte mécanique)
- Intérêt doit être prouvé en pratique clinique

Evaluation pré opératoire personnalisée des différentes techniques chirurgicales pour un patient spécifique