A novel biological device to secure and protect neophallus penile prosthesis cylinders and the neourethra following phalloplasty: Acellular matrix of intact penile Tunica made from human penis specimens following vaginoplasty

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Background and Purpose:

• Many transgender men wish to be able achieve erection when desired, for intercourse

• Common risks and challenges related to penile prosthesis placement after phalloplasty are:

  1. Migration of the cylinder proximally and distally within the neophallus
  2. Extrusion of the cylinder(s) through the phallus
  3. Infection of any anchoring anchoring materials (synthetic)
  4. Lack of phallus glans fullness

• Penile prosthetic devices are made of synthetic materials. Synthetics are at high risk for infection
• To date, no leading available penile prosthetics in use address neophallus anatomy in trans men

• Human fascia and acellularized tissues have been commonly used in reconstructive surgery
  – Fascia lata
  – Pericardium
  – Organ acellular matrix for seeding with stem-cells for regenerative medicine

  **Limitations**: Limited size; require intra-op cutting/suturing to desired dimensions ($$$$ OR time); durability ?)

• Synthetic graft materials (e.g. Dacron)
  **Limitations**: Cost (!); infection risk of porous cloth = higher/worse than for plastic
I. Fresh human penile tunica tissue could be used to construct “neo-corpora” for penile prosthesis placement in trans men and for other uses in reconstructive urology
   – Harvested as “whole-corpora” → rendered acellular
   – Proximal end is secured around proximal prosthesis, and is sutured (Ethibond) to pubic obturator ramus

II. With use of a single-cylinder prosthesis, the remaining tunical “tube” could be used to surround and protect the neourethra

III. Human glans tissue could be used to support the neophallus glans (provide fullness to minimize risk of extrusion and to support glans during sex
Materials & Methods:

- We used 5 fresh human penises, harvested at time of M to F vaginoplasty

- Specimens were without a portion of the anterior glans, NVB, and proximal urethra (harvested for use with vaginoplasty)

- Preserved glans/tunica shaft was at least 6.5 inches long (proximal dissection = gained length)
Early during chemical processing
• **Tissues rendered acellular with a chemical bath (gentle continuous stirring in beaker)**

1. Solution 1: 10mM PBS (pH 7.0) + 0.1% Sodium Azide; Mucosa scraped off with pair of glass slides; Inside of tunica hollowed out; 50mL of Solution 1 stirred for 1 week

2. Wash with PBS

3. Treat with Solution 2: 1M Sodium chloride (50mL) containing 2000 Kunitz units DNase I and stir for 41 days (smaller tissue for 5-6 hours). Once cell lysis is complete and all of the intracellular components are released, continue to next step (wash with 0.01% SDS solution and take off tissue once every week during DNase incubation; wash with PBS)

4. Solution 3: 50mL 4% Sodium Deoxycholate (4g in 100mL) containing 0.1% Sodium Azide (.1 g in 100mL) and stirred for 8 days

5. Tunica/Glans acellular matrix graft (TGAMG) washed 3 times with PBS
Results:

- Immunohistochemistry (IHC): Performed to assess for residual nuclei, cellular material and proteins and to identify collagen (H&E, Masson’s Trichrome)

- We inserted an inflatable and malleable penile prosthesis cylinder to assess “fit” and to grossly assess the strength of sutures placed into the matrix
H & E (Tunica - Corpora; 100x) + Nuclei
Early

H & E (Corpora; 100x) + Nuclei
Early

H & E (Glans 100x) + Nuclei
Trichrome (Glans; 100x)
Nearly acellular
• Penile prosthesis cylinder(s) fit well into tunical chamber(s)

• Good strength (withstood tension on 2-0 non-absorbable sutures = during prosthesis placement in a natal male)
Discussion:

• This is a novel application of an otherwise common approach of re-purposing human fascia for reconstructive surgery.

• Use of human “glans + tunica” addresses some of the current challenges with phalloplasty:
  
  – Creates a natural space for prosthetics
  – This space would facilitate cylinder replacement
  – Anchors the prosthesis to bone
  – *Could* be impregnated with antibiotics / antibiotic microspheres, to reduce infection risk
– Supports distal phallus glans
– With erection of inflatable → glans should be firmer
– Ingrowth of native, natural tissues significantly lowers risk of graft infection
– Serves to isolate the penile prosthetic (and urethra) from one another → to lower risk of cross infection and neourethral trauma during prosthesis placement

• For use with single cylinder: the un-used Tunica cylinder can be de-tubularized along lateral edge , and be wrapped around neourethra
Single Tunica chamber to surround / protect neourethra

(Lateral de-tubularizing incision)

( Single prosthesis cylinder inserted into A)

(B a’ & b’ Are wrapped around neourethra )
• This tunica/glans matrix could be placed at time of phalloplasty (construction of phallus/urethra)

• Limitations:
  * This was a proof-of-concept study
    - However, the protocol to render these tissues acellular can certainly be refined, made more efficient, etc.)

Next Steps and Future Directions:

• Animal Studies to confirm biocompatibility
• Human clinical trial
  – Assess bio-compatibility (first)
  – Efficacy trial (after)
Conclusions:

• The proposed Tunica & Glans acellular matrix graft has the potential to resolve significant challenges and limitations of neophallo-urethroplasty

• Can be used for more extensive non-transgender reconstructive urologic surgeries

• The proposed graft material can be harvested from cadavers or from living organ-donors

• Transgender surgery lacks its own implant & surgical devices; warrants attention via research & industry