Supplementary Information for:

Reversible Electroadhesion of Hydrogels to Animal Tissues for Suture-Less Repair of Cuts or Tears

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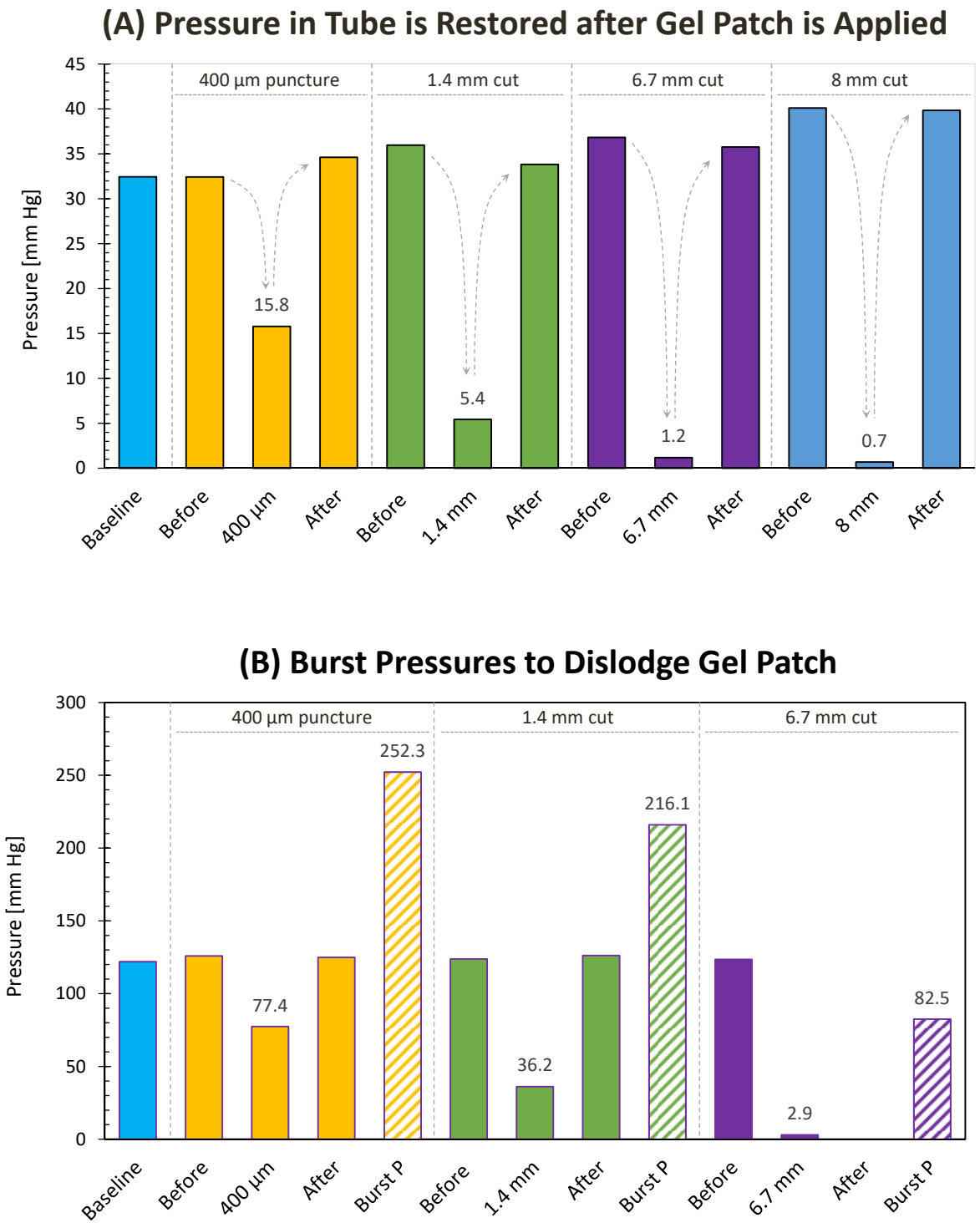
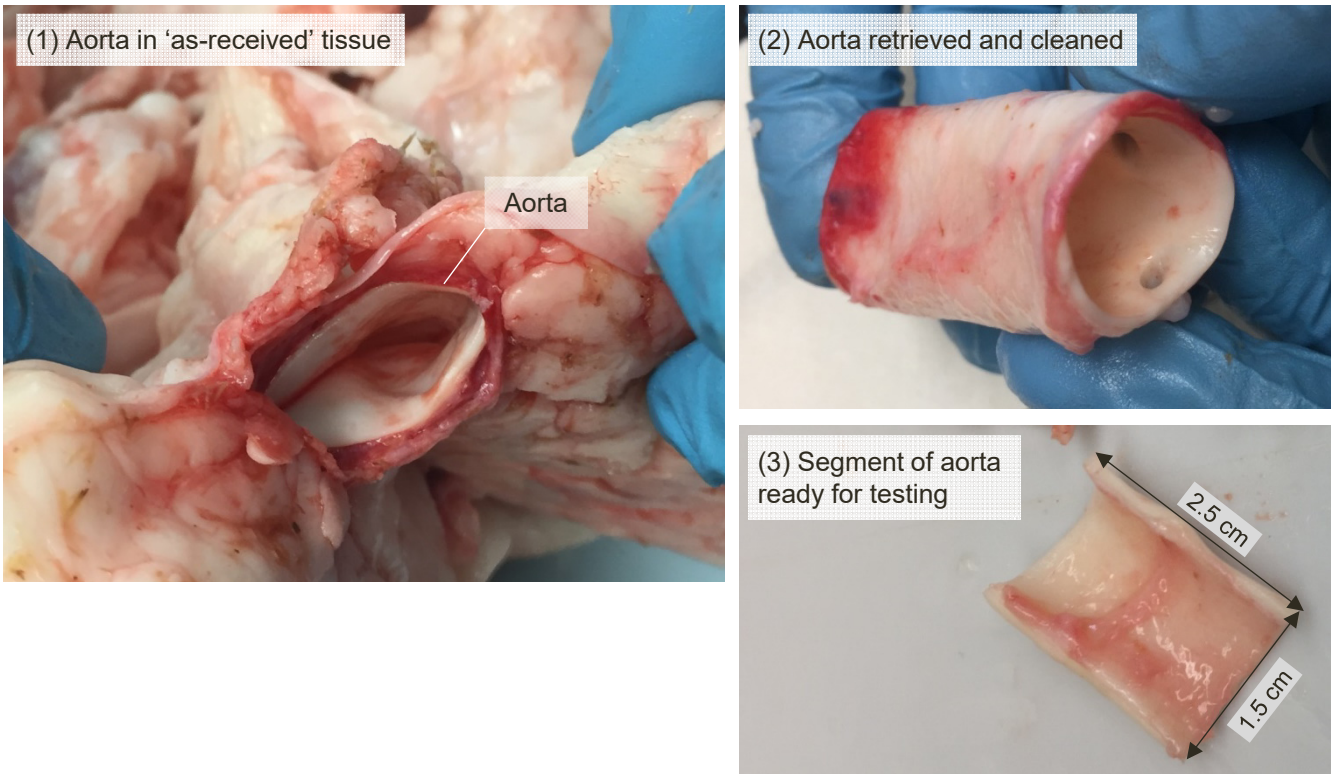
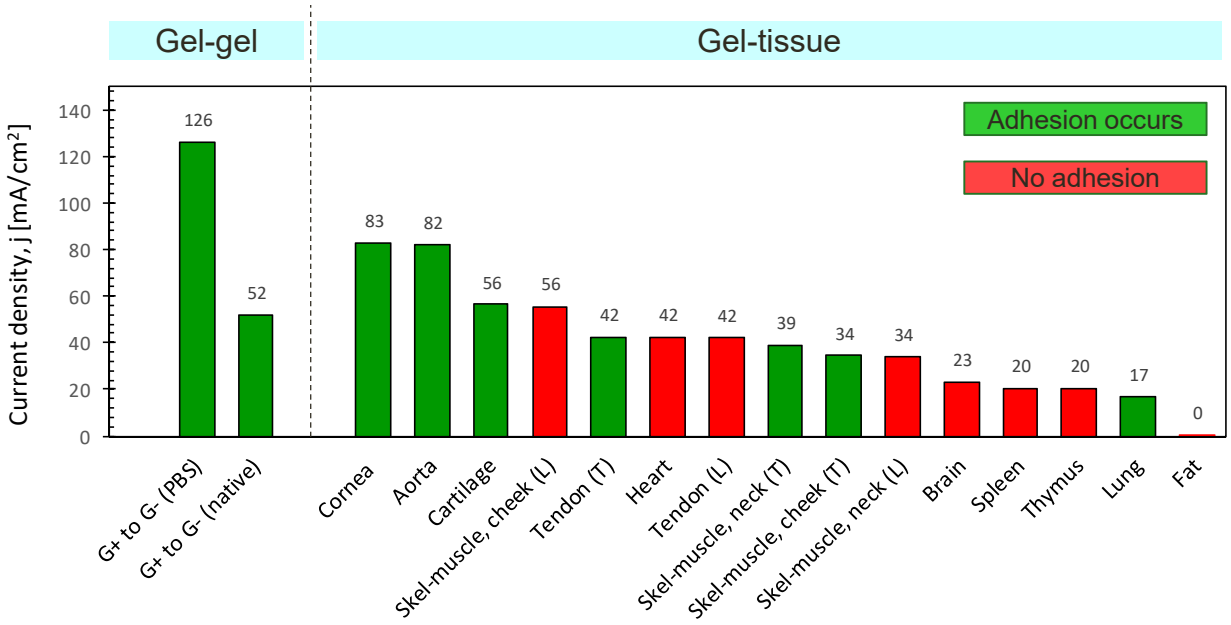
Contents



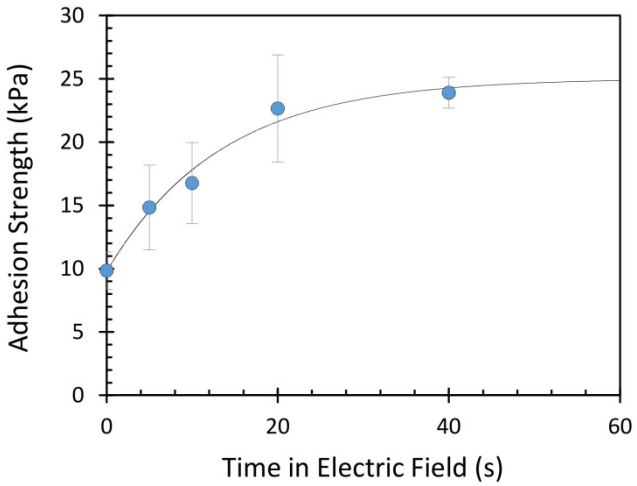
Supplementary Figure 1. Pressure changes in tube before and after applying a gel patch by electroadhesion. (A) Pressure readings before a puncture/cut is made in the wall of an alginate (Alg) tube and after the cut is sealed by electroadhesion of a QDM gel patch. Data are shown for different cut sizes, and for each case, the three bars are the readings for flow (i) before cut (baseline); (ii) when cut is made and not sealed; and (iii) after cut is sealed. In all cases, the pressure drops as fluid leaks out through the cut, but returns to baseline values once the cut is sealed. (B) For different cut sizes, data are further shown for the burst pressure required to dislodge the QDM gel patch from the tube wall. For these experiments, the baseline pressures are higher than in (A). Note that the burst pressure far exceeds the baseline pressure for small cut sizes.



Supplementary Figure 2. Preparation of a sample of bovine aorta for electroadhesion experiments. (1) As recieved, in the "raw" state, the aorta is encased in fat, and connected to other tissues. (2) The aorta is removed from the surrounding tissues and the fat encasings. (3) A segment of the aorta is cut to the desired size, comparable to the size of a gel segment. This is used for the electroadhesion experiments.



Supplementary Figure 3. Current density during electroadhesion experiments on gel-gel and gel-tissue pairs. All pairs were placed in an electric field of 10 V DC that was applied for 20 s. In the gel-gel cases, a cationic QDM gel (G^+) was contacted with an anionic SA gel (G^-). In the gel-tissue cases, the cationic QDM gel (G^+) was contacted with various tissues. In all experiments, the current I starts high and decreases with time. The highest recorded current is used to calculate the current densities j shown in the plot (note: $j = I$ / area of contact). The area of contact ranged between 1.6 and 2.4 cm^2 for the various tissues. No obvious correlation is seen between j and the occurrence of electroadhesion (refer to Table 1 in the text). The data for gel-gel pairs in their native state (i.e., as prepared in deionized water) or after soaking in PBS demonstrate that j mainly depends on the ionic strength of the fluid.



Supplementary Figure 4. Gel-tissue adhesion strength as a function of time in the electric field. Adhesion between QDM gels and aorta strips were measured after different durations of exposure to the field (10 V DC). The lap-shear technique was used and the stress-at-break was used to quantify the adhesion strength. The plot shows that electroadhesion develops within ~ 10 s in the field and the adhesion strength saturates by about 20 s. The data shown are averages (across at least three samples) and the error bars correspond to standard deviations. The line through the data is a guide to the eye.

Supplementary Table 1. Collagen, elastin, and water content of tissues that do and do not exhibit electroadhesion.

Adhesion				No Adhesion			
Tissue (Bovine)	Percent Collagen	Percent Elastin	Percent Water	Tissue (Bovine)	Percent Collagen	Percent Elastin	Percent Water
Aorta	23	40	84-87	**Heart**	3	0	74
Cornea	70		78	**Brain**	0.2	0	73
Lung	11	5	84	**Spleen**	3	5	79
Cartilage	58		80	**Fat**		9	50
				Thymus			
Tendon (transverse section)	85	5	55-70	**Tendon** (longitudinal section)	85	5	55-70
Skeletal muscle (transverse section)	2-7	0	80	**Skeletal muscle** (longitudinal section)	2-7	0	80

Values correspond to bovine tissue unless otherwise noted below. Values rounded to nearest integer.

Notes:

a. Aorta: Collagen and elastin compositions of aorta,[1] water content.[2]

b. Cornea: Collagen composition,[3] elastin percent values not given,[4] Water content.[5]

c. Lung: Collagen and elastin compositions of rat lung,[1] water content.[6]

d. Cartilage: Collagen composition of human cartilage,[7] elastin percent values not given,[8] water content.[9]

e. Tendon: Collagen and elastin compositions of tendon,[1] water content.[10]

f. Skelatel muscle: Collagen and elastin compositions of skeletal muscle,[11] water content.[6]

g. Heart: Collagen and elastin compositions of heart,[1] water content.[6]

h. Brain: Collagen and elastin compositions of rat brain,[1] water content.[6]

i. Spleen: Collagen and elastin compositions of spleen,[1] water content.[6]

j. Fat: Collagen percent values not given,[12] elastin composition of human adipose (fat) tissue,[13] water content.[6]

k. Thymus: Collegen percent values not given,[14] no data on elastin and water content available in literature.

Supplementary References

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