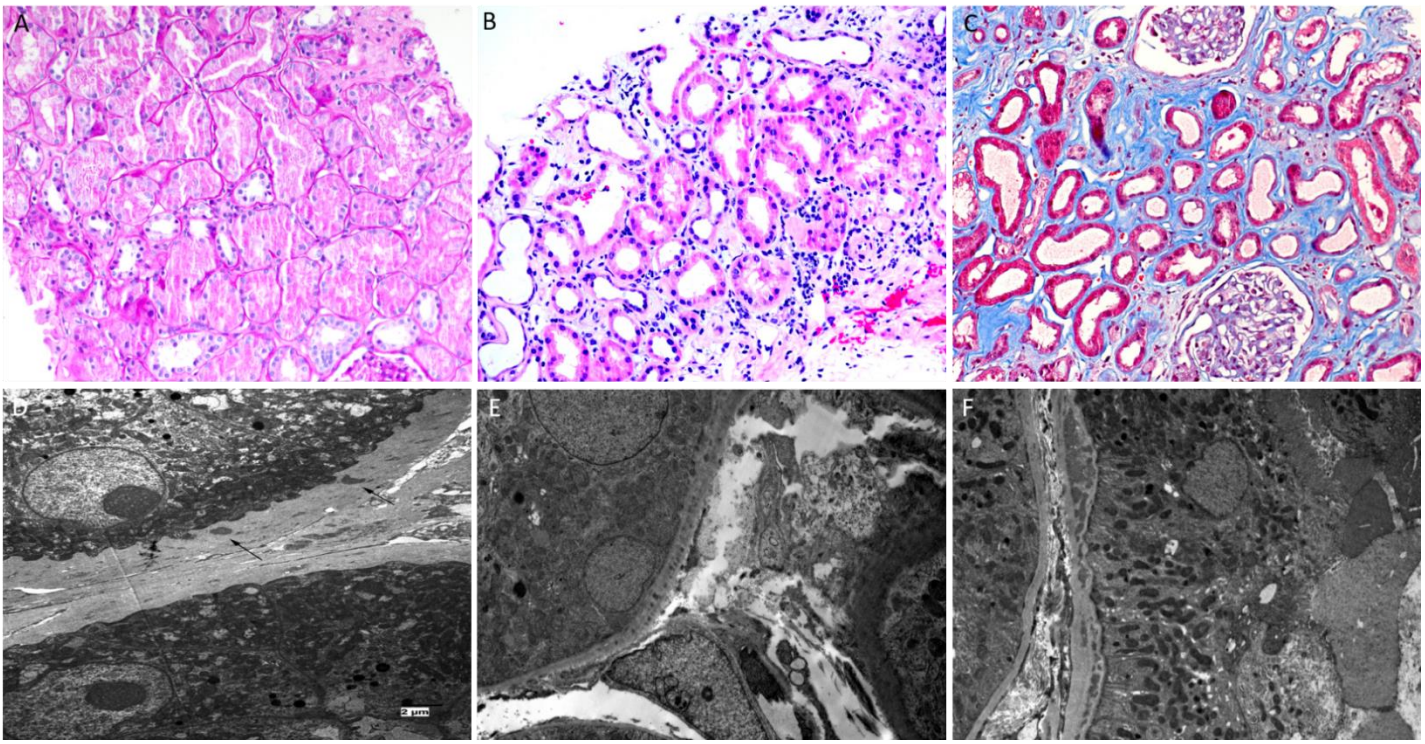
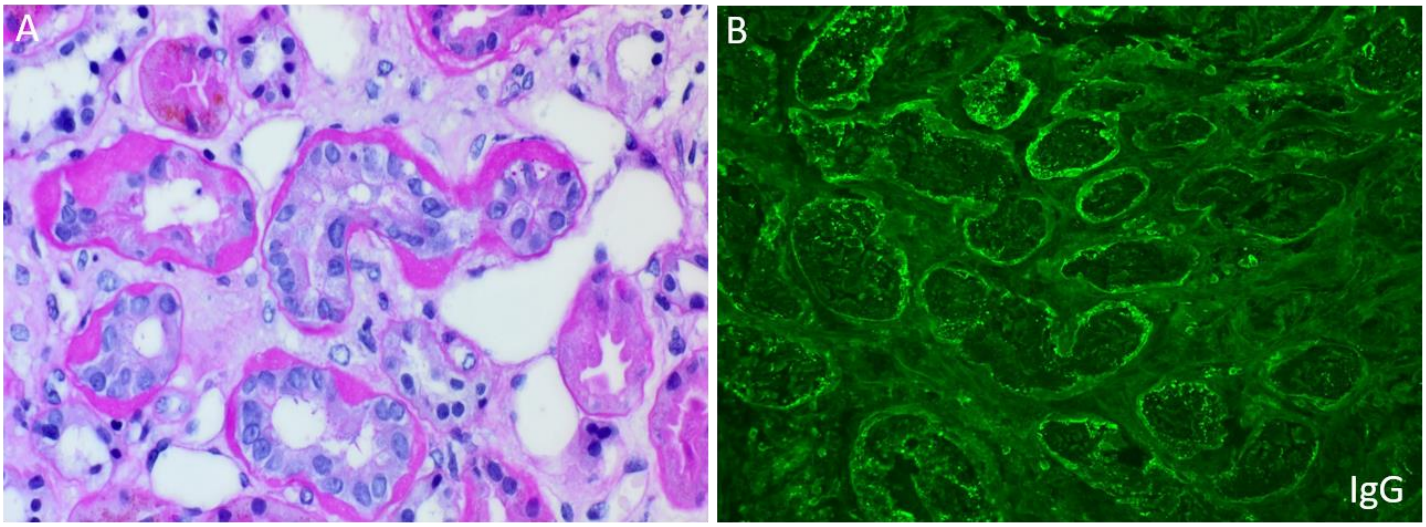
Supplemental Figures and Tables.

Supplemental Figure 1. Spectrum of tubular injury in ABBA. A. Relatively preserved tubulointerstitium, PAS stain 200x. B. Acute tubular injury with an increase in spacing between tubular profiles due to interstitial edema, epithelial simplification, and dilation, H & E stain 200x. C. A protracted pattern of tubular injury with interstitial fibrosis separating the tubular profiles with corresponding epithelial simplification, Masson Trichrome stain 200x. D - F. Deposition of electron dense immune-type deposits is variable, with few small to confluent large deposits.

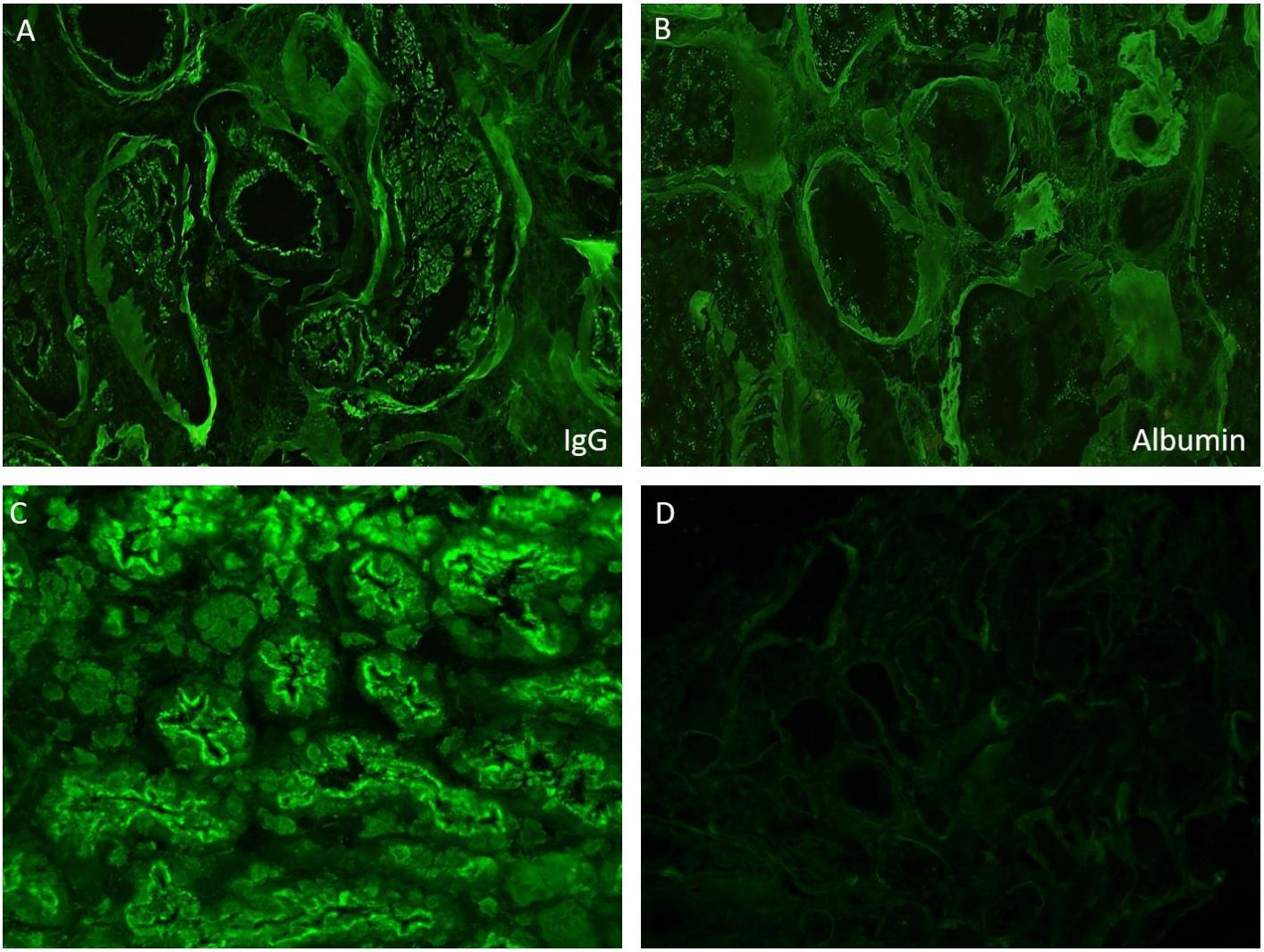


Supplemental Figure 2. Kidney biopsy showing a case of ABBA with tubular basement membrane deposits, but a lack of proximal tubular brush border staining. A. Severe acute tubular injury with a loss of brush borders, reactive nuclear changes, and large PAS-positive tubular basement membrane deposits, PAS stain, 600x. B. IgG staining along tubular basement membranes, IgG direct immunofluorescence, 400x.

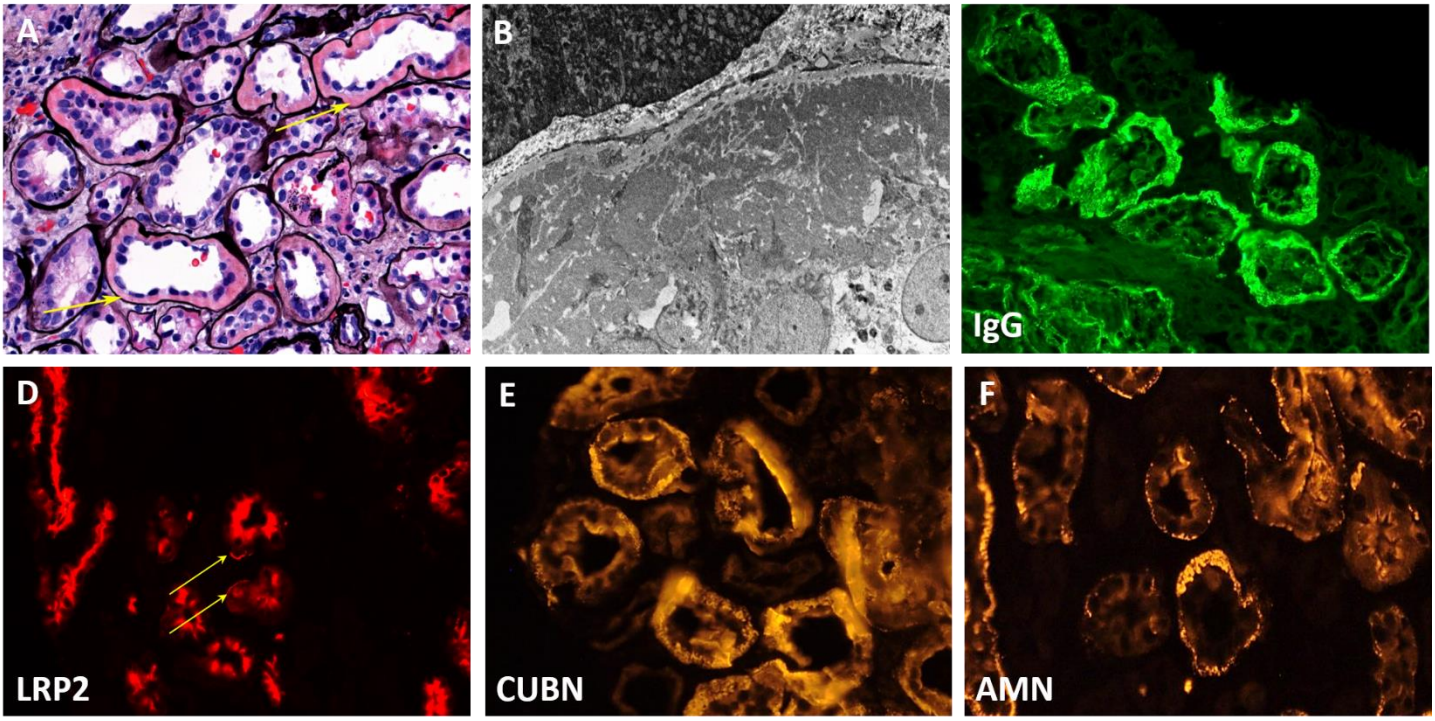


Supplemental Figure 3. Kidney biopsy showing a case of ABBA with IgG staining along the proximal tubular brush borders without corresponding tubular basement membrane deposits. A. IgG staining along the proximal tubular brush

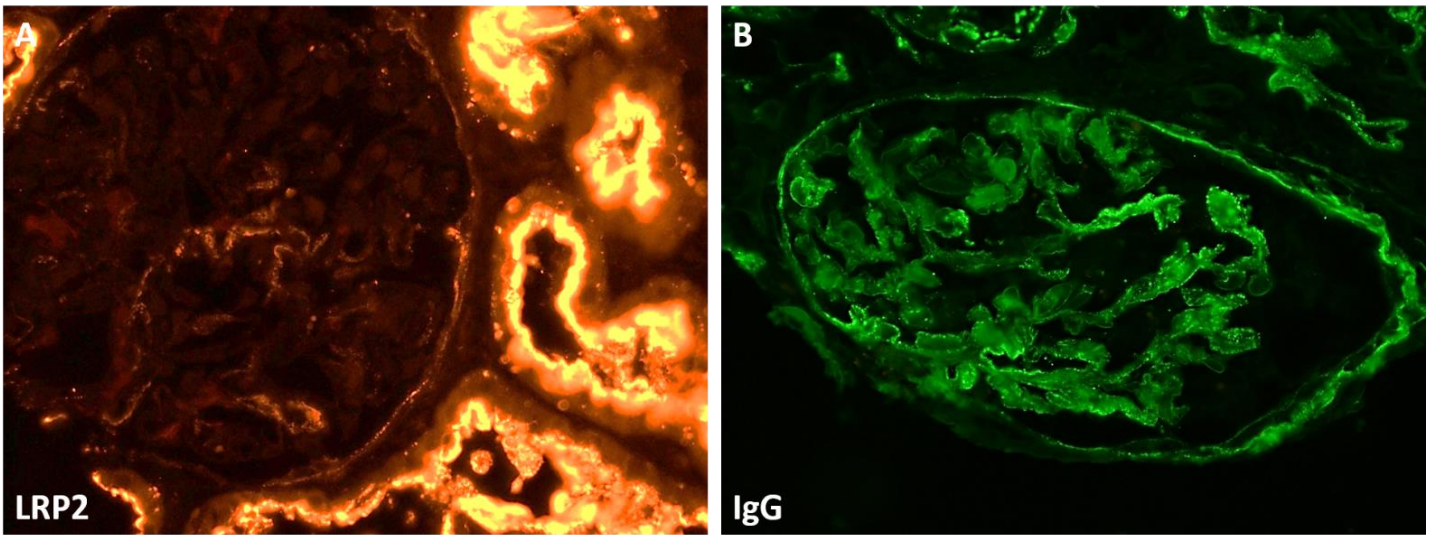
borders, 600x. B. Albumin staining is negative along the proximal tubular brush borders, 600x. C. An indirect immunofluorescence assay from patient sera demonstrates seroreactivity for IgG along the proximal tubular brush border, 400x. D. An indirect immunofluorescence assay from a healthy control shows a lack of staining along the proximal tubular brush borders, 400x.



Supplemental Figure 4. Patient biopsy with LRP2, CUBN, and AMN within tubular basement membrane deposits, suggestive of epitope spreading in the patient's ABBA disease. A. Acute tubular injury with large TBM deposits, Jones methenamine silver stain, 400x. B. Ultrastructural photomicrograph showing large electron dense immune type deposits along TBMs. C. IgG immunofluorescence along TBMs, 400x. D. LRP2 immunofluorescence showing focal positivity within TBM deposits, 400x. E. CUBN immunofluorescence showing positivity within TBM deposits, 600x. F. Immunofluorescence for AMN showing positivity within TBM deposits, 600x.



Supplemental Figure 5. LRP2 positivity in glomerular capillary loop deposits seen in a single case of ABBA. A. Paraffin immunofluorescence for LRP2 demonstrates a similar pattern of immune deposits (segmental capillary loop, Bowman's capsule, tubular basement membrane) as IgG staining (B).



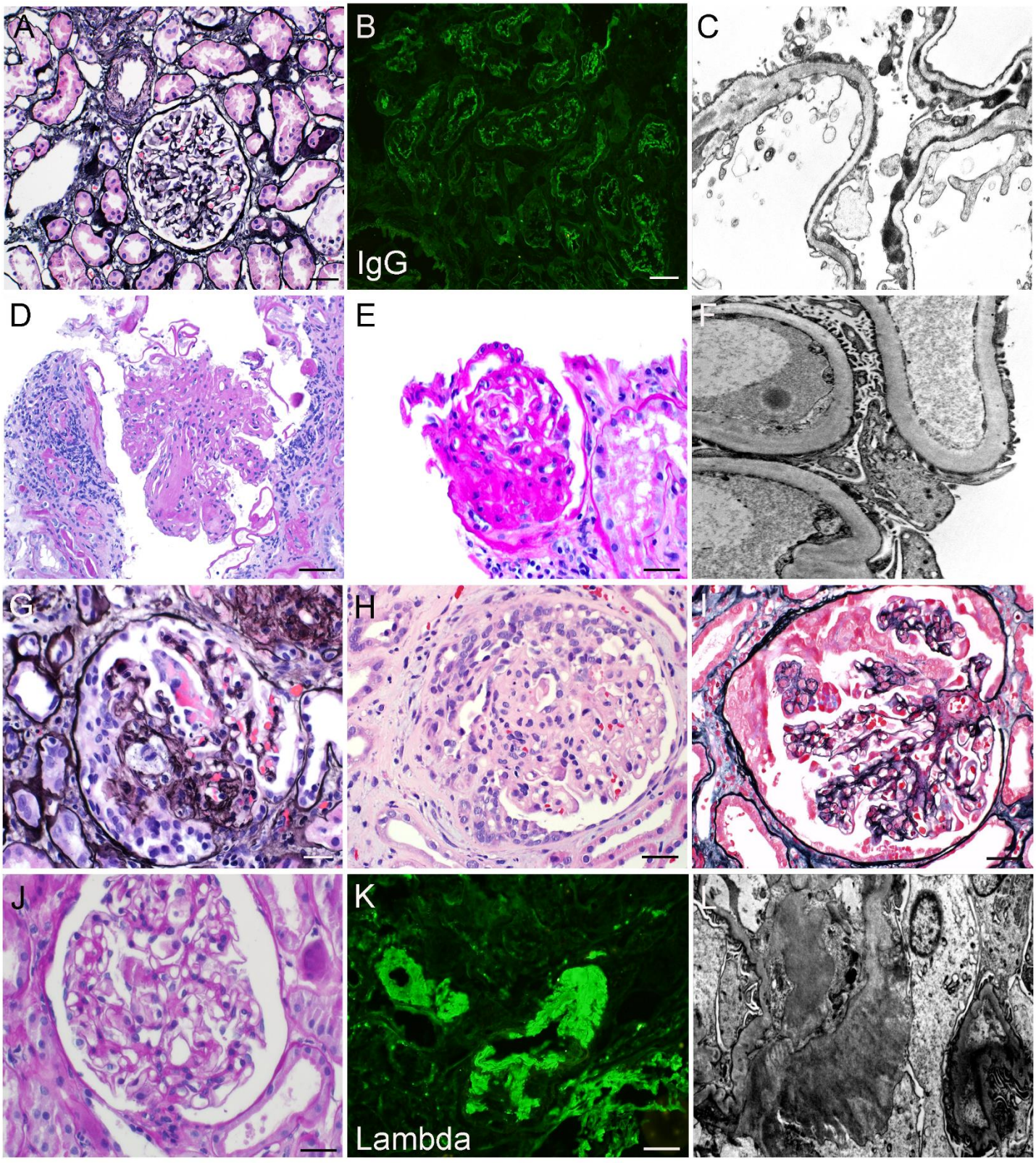
Supplemental Figure 6. Histopathologic spectrum of concurrent glomerular diseases in ABBA.

A - C) Case of minimal change disease in a patient with ABBA. A) Unremarkable glomerulus (Jones methenamine silver stain, original magnification 200x, scale bar = 50 μm). B) IgG immunofluorescence staining along proximal tubular brush borders (fluorescein-conjugated anti-human IgG, original magnification 200x, scale bar = 50 μm). C) Electron photomicrograph showing severe podocyte foot process effacement (original magnification 6000x).

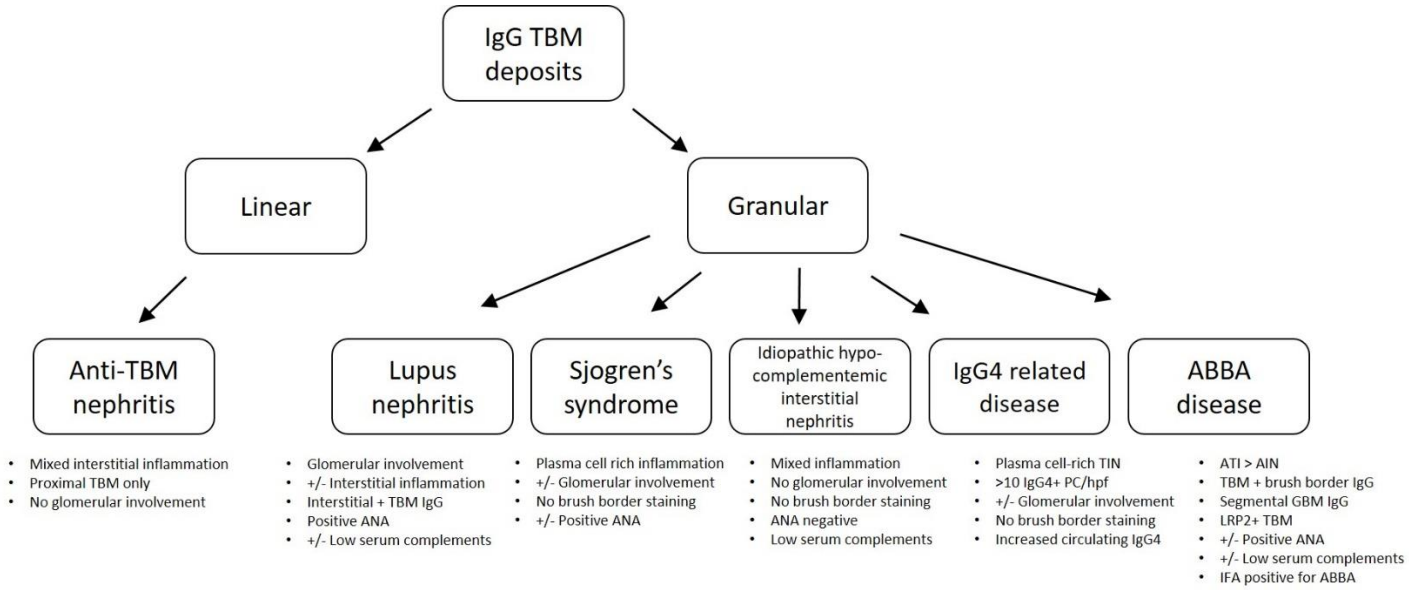
D-F) Case of diabetic glomerulopathy in a patient with ABBA. D) Nodular mesangial expansion in a glomerulus (PAS stain, original magnification 400x, scale bar = 20 μm). E) Glomerulus with mesangial expansion and segmental sclerosis (PAS stain, original magnification 400x, scale bar = 20 μm). F) Electron photomicrograph showing thickened glomerular basement membranes (original magnification 12000x).

G - I) Case of MPO-ANCA-associated crescentic glomerulonephritis in a patient with anti-brush border antibody disease. G) Glomerulus with fibrinoid necrosis and cellular crescent formation (Jones methenamine silver stain, original magnification 400x, scale bar = 20 μm). H) Glomerulus with a cellular crescent (H & E stain, original magnification 400x, scale bar = 20 μm). I) Glomerulus with disruption of the capillary tuft by a cellular crescent, (Silver methenamine Masson trichrome stain, original magnification 400x, scale bar = 20 μm).

J - L) AL amyloidosis in a patient with anti-brush border antibody disease. J) Amorphous mesangial expansion in a glomerulus (PAS stain, original magnification 400x, scale bar = 20 μm). K) Immunofluorescence staining showing amorphous staining for lambda light chain with vessels (fluorescein conjugated anti-human lambda light chain staining, original magnification 400x, scale bar = 20 μm). No corresponding kappa light chain staining was present (data not shown). L) Electron photomicrograph showing mesangial replacement with capillary loop extension by small overlapping fibrils, consistent with amyloid (original magnification 15000x).


A
B
IgG
C
D
E
F
G
H
I
J
K
Lambda
L

Supplemental Figure 7. Diagnostic algorithm for tubulointerstitial kidney diseases with tubular basement membrane IgG deposits.



Supplemental Table 1. Patient characteristics with post-transplant recurrence

Pt	Age	Sex	ESKD	Time	Presentation	Post-transplant biopsies	Treatment	Outcomes
1	60	M	MN	2.5 y	AKI Nephrotic syndrome AKI, minimal proteinuria	Podocytopathy x 3 LRP2 nephropathy x 3 LRP2 nephropathy, no podocytopathy	Steroids Tacrolimus Mycophenolate Plasmapheresis (after 3rd bx)	No remission
2	16	M	Unknown	6 y	AKI Sub-nephrotic proteinuria Positive DSA	ABMR, C4d Positive LRP2 nephropathy ABMR, C4d Positive LRP2 nephropathy	Steroids Tacrolimus Mycophenolate Plasmapheresis	No remission

Abbreviations: ESKD, end-stage kidney disease; M, male; y, years; AKI, acute kidney injury; DSA, donor-specific antibodies; bx; biopsy.

Supplemental Table 2. Patient characteristics with CR, SR, and PR (n=16 patients)

No.	Cr initial (mg/dL)	Cr follow-up (mg/dL)	IF/TA	ABBA titer initial	ABBA follow-up titer	Treatment	Follow-up (days)	Concurrent disease?
Patients with CR								
1	3.0	1.0	Moderate	1:1000	1:100 (at 4 months), Negative (at 11 months)	Steroids + Cyclophosphamide	365	None
2	3.21	1.0	Mild	Negative	Negative	Prednisone	1014	MCD

3	Unknown	0.44	None	N/A	N/A	Prednisone	362	MCD
4	1.6	1.1	Mild	N/A	N/A	Prednisone + MMF	498	Focal LN
5	2.6	1.2	Mild	N/A	N/A	Prednisone + MMF	70	Focal crescentic GN
Patients with SR								
1	3.8	1.6	Moderate	N/A	N/A	Prednisone + Rituximab	90	Focal crescentic GN
2	3.5	1.6	None	1:100	Negative	Steroids + MMF + Tacrolimus	720	FSGS-tip variant
3	6.7	2.2	Severe	1:1000	1:1000	No treatment	320	None
Patients with PR								
1	2.3	1.9	Moderate	1:100	N/A	None	31	Artneph
2	5	2.6	Severe	1:1000	N/A	Prednisone	90	None
3	3.2	1.7	Moderate	N/A	N/A	Prednisone + MMF	224	None
4	2.0	1.6	Severe	1:100	Negative	Prednisone + MMF	720	MN
5	3.6	1.4	Moderate	N/A	Negative	Prednisone + Rituxumab	102	IgAN
6	1.6	1.3	Moderate; Mild	N/A	N/A	Prednisone + cyclophosphamide	320	None
7	11	2.2	Severe	N/A	N/A	Prednisone + MMF	141	Chronic active TIN

Abbreviations: No., patient number; Cr, serum creatinine; IF/TA, interstitial fibrosis/tubular atrophy; ABBA, anti-brush border antibodies; CR, complete remission/response; SR, significant response; PR, partial response; N/A, not applicable; MMF, mycophenolate mofetil; MCD, minimal change disease; LN, lupus nephritis; GN, glomerulonephritis; FSGS, focal segmental glomerulosclerosis; IgAN, IgA nephropathy; Artneph, Arterionephrosclerosis; MN, membranous nephropathy; TIN, tubulointerstitial nephritis.

Supplemental Table 3. Patient characteristics with no remission (n=36 patients).

No.	Cr initial (mg/dL)	Cr follow-up (mg/dL)	IF/TA	ABBA titer initial	ABBA follow-up titer	Treatment	Follow-up (days)	Concurrent disease?
1	8.8	ESKD	Mild	1:100	1:10	Prednisone	240	None
2	2.7	4.2	Moderate	1:500	N/A	Prednisone + ACEi, transplant	720	None
3	7.6	ESKD	Mild	N/A	N/A	Prednisone	Unknown	Proliferative GN, IC-type
4	14.7	ESKD	Moderate	1:100	N/A	Prednisone	45	Artneph
5	3.6	3.4	Limited - scant cortex	N/A	N/A	Prednisone	35	Nodular diabetic glomerulosclerosis
6	1.3	0.9 (post-transplant)	Moderate	1:100	N/A	Prednisone + transplant	Unknown	None
7	1.7	2.2	Mild	1:100	N/A	Rituximab	120	None
8	2.1	2.4	Mild	1:100	1:10	Rituximab	90	None
9	1.4	1.6	Moderate	N/A	N/A	Rituximab	588	None
10	N/A	N/A Deceased	Severe	N/A	N/A	Prednisone + Cellcept	120	Granulomatous TIN
11	3.8	ESKD	Moderate	1:1000	N/A	Bortezomib + Rituximab + Dexamethasone	150	None
12	4.4	ESKD	Moderate	1:1000	N/A	Prednisone + Rituximab	365	None
13	1.49	1.5	Mild	N/A	N/A	Plasmapheresis + MMF + Prednisone + Tacrolimus, transplant	226	None
14	1.35	1.75	Mild	N/A	N/A	Daratumumab	319	AL Lambda Amyloidosis
15	1.8	1.9	Moderate	N/A	N/A	SGLT2 inhibitor, no immunosuppression	344	None
16	1.8	2.4	Moderate	N/A	N/A	SGLT2 inhibitor, no immunosuppression	Unknown	Nodular diabetic glomerulosclerosis
17	2.2	2.3	Severe	1:500	1:500	None	390	None
18	1.67	N/A; Deceased	Moderate	1:10	N/A	N/A	N/A	None
19	2.8	N/A; Deceased	Moderate	1:100	N/A	N/A	N/A	Artneph
20	2.7	N/A; Deceased	Moderate	1:1000	N/A	None	N/A	None
21	2.1	3.1	Moderate	N/A	N/A	None	365	None
22	2.3	2.2	Moderate	N/A	N/A	Prednisone + MMF	600	None

23	2.1	5.0	Moderate	N/A	N/A	None	270	None
24	3.0	6.0	Moderate	N/A	N/A	None	104	IgA nephropathy
25	5.0	5.9	Moderate	N/A	N/A	None	192	Membranous nephropathy
26	3.79	ESKD	Severe	N/A	N/A	None	61	Nodular diabetic glomerulosclerosis
27	7.2	N/A; Deceased	Mild	N/A	N/A	None	10	ATI with myoglobin casts
28	1.5	2	Severe	N/A	N/A	None	229	Artneph
29	6.28	1.4* + nephrotic syndrome	Mild	N/A	N/A	Prednisone	60	None
30	6.3	3.2	Severe	N/A	N/A	Prednisone	180	None
31	2.6	3.1	Severe	1:10	N/A	Prednisone	24	Arterionephrosclerosis
32	2.1	5.0	Moderate	N/A	N/A	None	270	None
33	5.8	ESKD	Moderate	N/A	N/A	Vincristine, cyclophosphamide, doxorubicin (for B cell lymphoma)	112	Atypical lymphoid infiltrate
34	3.4	ESKD	Severe	N/A	N/A	None	73	None
35	6.5	7.1; ESKD	Moderate	N/A	N/A	None	175	Atypical lymphoid infiltrate
36	6.5	3.8	Severe	N/A	N/A	Chemotherapy for B cell lymphoma	210	None

Abbreviations: No., patient number; Cr, serum creatinine; IF/TA, interstitial fibrosis/tubular atrophy; ABBA, anti-brush border antibodies; ACEi, angiotensin-converting enzyme inhibitor; GN, glomerulonephritis; IC, immune complex; Artneph, arterionephrosclerosis; N/A, not applicable; TIN, tubulointerstitial nephritis; SGLT2, sodium-glucose cotransporter-2; ATI, acute tubular injury.

Supplemental Table 4. Comparison of ABBA patients who had serologic testing compared to patients without serologic disease confirmation. Two cases (one in each group) was a limited cortical sample and could not be analyzed for all histologic parameters.

Parameter	Serologic testing performed n=30	Serologic testing not performed n=37
Histopathology		
% Global glomerulosclerosis	26.8 ± 16.1	28.2 ± 21.4
Interstitial fibrosis - None - Mild - Moderate - Severe	 1/29 (3.4%) 8/29 (27.6%) 16/29 (55.2%) 4/29 (13.8%)	 1/36 (2.8%) 10/36 (27.8%) 17/36 (47.2%) 8/36 (22.2%)
Tubular atrophy - None - Mild - Moderate - Severe	 3/29 (10.3%) 6/29 (20.7%) 16/29 (55.2%) 4/29 (13.8%)	 2/36 (5.6%) 9/36 (25.0%) 16/36 (44.4%) 9/36 (25.0%)
Interstitial edema (present/absent)	20/30 (66.7%)	26/37 (70.3%)
IgG TBM deposits (present/absent)	30/30 (100%)	36/37 (97.3%)
IgG brush borders (present/absent)	20/30 (66.7%)	33/37 (89.2%)
IgG Bowman's capsule (present/absent)	23/29 present (79.3%) 6/29 absent (20.7%)	23/37 present (62.2%) 14/37 absent (37.8%)
IgG capillary loop (present/absent)	27/29 present (93.1%) 2/29 absent (6.9%)	29/37 present (78.4%) 8/37 absent (21.6%)
Time of biopsy clinical parameters		
Serum creatinine at diagnosis (mg/dL)	Mean 2.5 ± 2.8 Median 2.6	Mean 3.7 ± 2.5 Median 3.16
Proteinuria at diagnosis (grams/day)	Mean 2.8 ± 3.3 Median 1.5	Mean 2.7 ± 2.7 Median 1.6
Hematuria (present/absent)	16/22 (72.7%)	14/22 (63.6%)
ANA positivity or autoimmune disease (present/absent)	13/25 (52%)	7/15 (46.7%)
Monoclonal paraprotein (present/absent)	9/24 (37.5%)	10/20 (50%)
Follow-up data		
Serum creatinine at follow-up (mg/dL)	Mean 2.2 ± 1.3 Median 1.9	Mean 2.8 ± 1.8 Median 2.2
Proteinuria at follow-up (grams/day)	Mean 1.1 ± 1.0 Median 0.85	Mean 1.9 ± 2.4 Median 0.99
Remission (CR, SR, or PR) - CR - SR - PR - NR	n=26 4 CR (15.4%) 2 SR (7.7%) 4 PR (15.4%) 16 NR (61.5%)	n=25 2 CR (8.0%) 1 SR (4.0%) 4 PR (16.0%) 18 NR (72.0%)
No remission	17/26 (65%)	15/29 (51.7%)
Dialysis or ESKD	7	9

Supplemental Table 5. Comparison of IgG subclass staining within serum and kidney biopsy tissue.

Case	Predominant IgG subclass serum	Predominant IgG subclass biopsy
1	4	1 and 4
2	1 and 4	1 and 4
3	4	4
4	4	1, 2, and 4
5	4	1 and 4
6	4	1 and 4
7	4	1
8	1 and 4	1 and 4
9	4	1 and 4
10	1 and 4	1 and 4
11	1	1,2, and 4
12	1 and 4	1 and 4
13	1 and 4	1, 2, and 4
14	4	4