Assessment of Mechanical Properties of Tissue in Breast Cancer-Related Lymphedema Using Ultrasound Elastography

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This supplementary material provides detailed comparison of GLUE and GLUE2 in simulation and phantom experiments (Tables I and II), as well as detailed numerical values of strain and strain ratio (SR) in the clinical data (Table III).

I. Supplementary Material

SNR and CNR values are calculated using the background windows in Figure 1 (a) and (d) of the paper. CNR values are obtained from the target and background windows (16 CNR measurements). The histogram of Figure 1 below demonstrates the CNR values for GLUE and GLUE2 in axial and lateral strain images. These results also validate that GLUE2 outperforms GLUE especially in the axial strain, which is much more widely used compared to the lateral strain by providing a 190% improvement in average CNR (52.74 versus 18.15).

In the simulation experiment, SNR values of the strains are calculated using the background windows in Figure 1 (a) and (d) of paper and the average values are shown in Table 1 below. CNR values are obtained from the target and background windows (16 CNR measurements). These results also demostrate that GLUE2 outperforms GLUE.

In phantom results, the SNR and CNR are calculated for the 3 regions using the windows shown in Figure 4 (b) of the paper and the average is calculated in Table II for the GLUE and GLUE2 methods. The target and background windows for CNR estimation are placed in the tissue-mimicking phantom and the gel pad respectively. The proposed method has 28% and 24% improvements in terms of CNR and SNR over the previous technique, GLUE.

TABLE I
THE CNR AND SNR VALUES OF THE STRAIN IMAGES OF THE SIMULATION DATA IN FIGURE 1 OF THE PAPER. MAXIMUM VALUES ARE IN BOLD FONT.

	CNR		SNR	
	GLUE	GLUE2	GLUE	GLUE2
Axial	18.15	**52.74**	14.68	**15.01**
Lateral	10.51	**12.55**	4.33	**4.40**

TABLE II
THE CNR AND SNR VALUES OF THE STRAIN IMAGES OF THE PHANTOM EXPERIMENT IN FIGURE 4 OF THE PAPER.

	GLUE	GLUE2
CNR1	9.06	12.76
CNR2	18.96	22.90
CNR3	18.12	23.34
CNR (Ave.)	15.38	19.67
SNR1	8.68	7.18
SNR2	7.53	10.85
SNR3	6.39	10.08
SNR(Ave.)	7.53	9.37

Based on Table IV of the paper that reports the results on patient data, landmarks 2, 3 and 5 have the highest difference of strain values between the unaffected and affected arms. The S and SR values for these landmarks are reported in Table III below.

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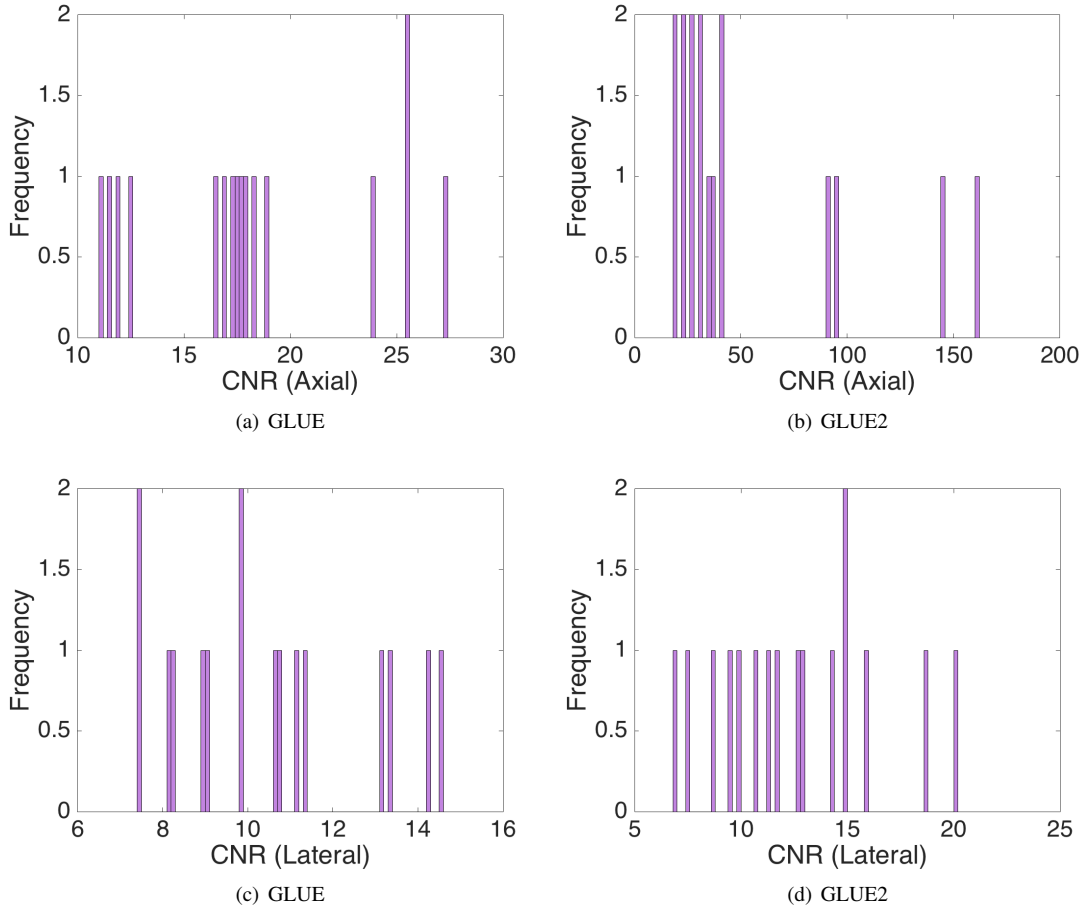

(a) GLUE (b) GLUE2

(c) GLUE (d) GLUE2

Fig. 1. CNR values of the lesion, obtained from GLUE and GLUE2 methods. The windows in Fig. 1 (a) & (d) are used to estimate 16 CNR measurements, which are shown in these histograms.

TABLE III
SR AND S VALUES FOR THE LANDMARKS 2, 3, AND 5 IN SKIN, FAT, AND MUSCULAR TISSUES (U = UNAFFECTED AND A = AFFECTED).

	SR						**S**					
	Skin		Fat		Muscle		Skin		Fat		Muscle	
Location 2	U	A	U	A	U	A	U	A	U	A	U	A
Patient 1	0.2569	0.0939	0.2298	0.1984	0.3632	0.3393	0.0032	0.0017	0.0028	0.0036	0.0045	0.0062
Patient 2	0.4481	0.5086	0.7551	0.4741	1.104	0.6675	0.0047	0.005	0.0076	0.0047	0.0111	0.0066
Patient 3	0.2949	0.1315	0.21	0.1783	0.5356	0.2834	0.0038	0.0023	0.0027	0.0031	0.007	0.0094
Patient 4	0.4234	0.2832	0.4141	0.0591	0.7797	0.2714	0.006	0.0053	0.0059	0.0011	0.0111	0.005
Patient 5	0.5634	0.4866	1.654	0.2715	0.755	0.1375	0.005	0.0102	0.0145	0.0057	0.0066	0.0029
Patient 6	0.8404	0.3308	0.5432	0.1707	0.4831	0.3489	0.016	0.0098	0.0104	0.0051	0.0092	0.0104
Patient 7	0.4327	0.2826	0.4343	0.3141	0.4218	0.1684	0.0069	0.0055	0.007	0.0061	0.0068	0.0032
Average	**0.47**	**0.30**	**0.60**	**0.24**	**0.64**	**0.32**	**0.0065**	**0.0056**	**0.0070**	**0.0042**	**0.0080**	**0.0062**
Location 3												
Patient 1	0.8289	0.103	0.6437	0.1616	1.2174	0.2207	0.0088	0.0021	0.0069	0.0032	0.013	0.0044
Patient 2	0.6282	0.3282	0.4779	0.2299	0.5544	0.2848	0.0081	0.0074	0.0062	0.0052	0.0072	0.0064
Patient 3	0.5488	0.3169	0.4796	0.2509	1.0987	0.748	0.0065	0.0054	0.0057	0.0043	0.013	0.0128
Patient 4	0.268	0.2427	0.1786	0.1724	0.5451	0.4156	0.0057	0.0051	0.0038	0.0036	0.0117	0.0088
Patient 5	0.5209	0.5038	0.6688	0.3108	1.1335	0.5181	0.0039	0.0086	0.005	0.0053	0.0085	0.0088
Patient 6	1.4490	0.4443	0.7150	0.2698	1.0047	1.7480	0.0115	0.0055	0.0057	0.0034	0.008	0.0218
Patient 7	0.4196	0.2802	0.2545	0.2033	0.7022	0.1544	0.0086	0.0116	0.0052	0.0084	0.0144	0.0064
Average	**0.67**	**0.32**	**0.49**	**0.23**	**0.89**	**0.59**	**0.0075**	**0.0065**	**0.0055**	**0.0047**	**0.0108**	**0.0099**
Location 5												
Patient 1	0.6451	0.5063	0.6169	0.3623	1.8268	0.5882	0.0041	0.0066	0.0039	0.0047	0.0116	0.0076
Patient 2	0.5168	0.3337	1.1071	0.5452	1.475	0.4045	0.0052	0.0049	0.0112	0.0081	0.0149	0.006
Patient 3	0.6173	0.1945	1.0203	0.4715	2.1202	1.4337	0.0048	0.0026	0.008	0.0063	0.0166	0.0196
Patient 4	0.2467	0.2333	0.4975	0.1166	0.9293	0.2691	0.0034	0.0064	0.0069	0.0032	0.0129	0.0074
Patient 5	0.5547	0.1935	1.1065	0.1873	0.9591	0.4493	0.0059	0.0046	0.0118	0.0044	0.0103	0.0106
Patient 6	0.9160	0.6077	1.3439	0.8208	0.9089	0.8714	0.0089	0.0074	0.013	0.01	0.0088	0.0106
Patient 7	0.4058	0.7646	1.0107	0.9715	1.0877	0.8498	0.0109	0.0033	0.0273	0.0042	0.0293	0.0036
Average	**0.56**	**0.40**	**0.95**	**0.50**	**1.32**	**0.69**	**0.0061**	**0.0051**	**0.0117**	**0.0058**	**0.0149**	**0.0093**