in Section 5.3.2 by working though a sample dataset result.

5.2.3 Model Validation

In order to validate the results presented in Section 5.3, a subset of the results were compared with experimental results obtained with a physical tissue mimicking phantom. The phantom used was the same CIRS Elasticity QA Phantom model 049 that was used in Chapter 3. The phantom models both stiff and unstiff lesions at two different depths and lesion sizes. The material properties of the phantom are listed in Table 3.2. Both tissue and lesion shear wave speeds were acquired using a Siemens AG ACUSON S2000™ ultrasound system running the Virtual Touch™ Quantification unstiffware suite with a Siemens 9L4 transducer. Measures of relative lesion stiffness were calculated as per equations 5.12 in an identical fashion to the simulated lesion cases and experiments were carried out over 10 trials for each investigated nominal lesion stiffness ratio. The detailed experimental protocol that was followed for these validations is given in Section C.3 in Appendix C.

5.3 Results and Discussion

Following the procedure outlined in Section 5.2, k-space models of ultrasound acoustics and finite-element models of temporal soft tissue deformation were synthesized and the resulting shear wave speeds developed in the tissue were analyzed according to the method laid out in Section 5.3.2. These shear wave speeds were used to calculate the relative stiffnesses of a variety of lesions with varying parameters as described in Section 5.2.2 which were then used to numerically characterize the use of shear wave speed quantification for the detection of early deep tissue injuries. The results of this characterization are presented here.

5.3.1 Acoustic Radiation Force Impulse Simulations

Since the acoustic radiation force impulse simulations were run in exactly the same manner for shear wave speed quantification as in the ARFI imaging presented in Chapter 4, the results are identical—see Section 4.3.1 for the results. For completeness, the force distribution which generated the shear waves studied in Section 5.3.2 is plotted in Fig. 5.2. against a schematic of the lesion in order to better visualize the shear wave speed quantification process. Fig. 5.2 shows the focal line of the shear wave speed quantification technique, along which the axial displacement of the tissue is continuously monitored in order to calculate the localized shear wave speed of the tissue. This focal line extends laterally from the focal point of the acoustic radiation force impulse through the lesion to the edge of the tissue domain.

5.3.2 Sample Shear Wave Speed Measurement

Although measuring the shear wave speed of tissue may quantify the tissue stiffness through equation 5.11, the results presented here represent the measured stiffness ratio of lesions in order to present continuity with Chapters 3 and 4. In all cases where relative lesion stiffness is presented, it was calculated through comparison of the mean shear wave speed in the defined lesion region with the mean shear wave speed outside of the lesion region along the path of the lateral shear wave radiation direction. Specific ratios may be calculated using equation 5.12 where E_{rel} is the relative stiffness ratio, μ_l and μ_t are