Bed-type oscillator for MR Elastography

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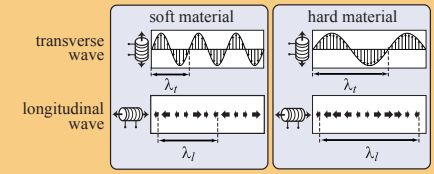
1.Introduction

- Magnetic resonance elastography (MRE) has been developed to provide noninvasive measurements of elasticity for human tissue.
- In MR Elastography method, external oscillations are applied to the object with known frequency, and the acoustic strain waves caused by the oscillations are visualized in MR images.
- Then the shear modulus and Young's modulus are calculated by measuring transverse and longitudinal wavelength from the images[1].

- Purpose of this research
  - The aim of our research is to create an oscillator that
  - **generates a flat transverse wave** in a

2.Background

Calculation of the elasticity from the wavelength



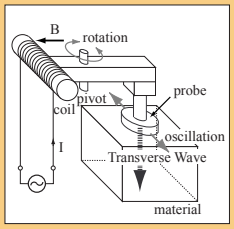
Shear Modulus : $G=\rho(f_l\lambda_t)^2$: calculated from λ_t

Young's Modulus : $E=\rho\dfrac{3\rho G(f_l\lambda_l)^2-4G^2}{\rho G(f_l\lambda_l)^2-G^2}$: calculated from λ_t and λ_l

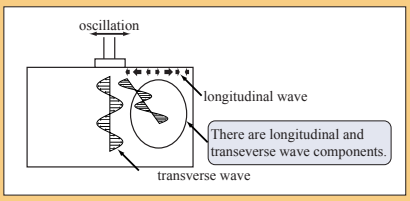
ρ : density of the material

Probe-type oscillator (Previous method)

- In most MRE studies in vivo or ex vivo, a small probe that contact the target object was used to provide oscillation [1].
- The probe-type oscillator generates spherical wave.



Limitation of the probe-type oscillator

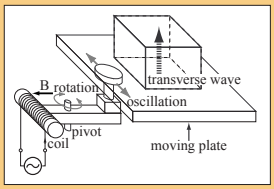


- Difficult to calculate λ_t and λ_l at each point.

3.Methods

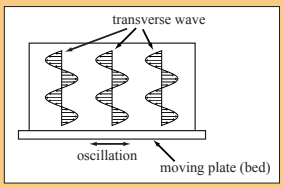
Bed-type oscillator

- To produce pure transverse wave, we designed a bed-type oscillator.
  - The system has a moving plate under the
  - measuring object to generate a flat wave.



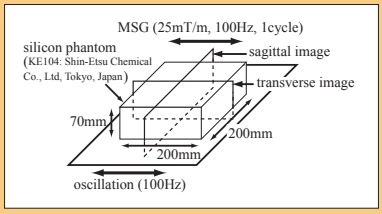
Feature of the bed-type oscillator

- The bed-type oscillator generates a flat wave in the measurement object.
  - A flat wave is propagated along every line orthogonal
  - to the moving plate.
  - It facilitates the analysis of wavelength



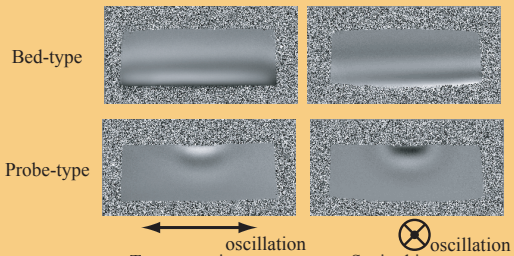
4.Phantom study

- In the first experiment, a silicon phantom was imaged by the probe-type oscillator and the bed-type one.



Acquisition system : Magnetom Sonata (Siemens AG, Erlangen, Germany).

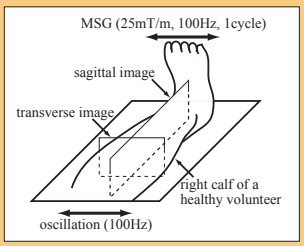
Results



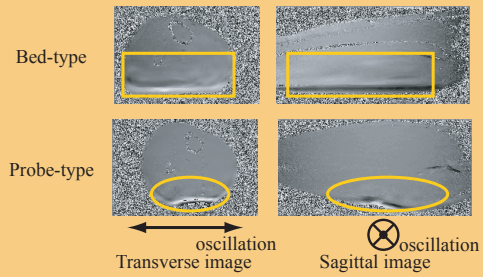
- Bed-type oscillator can generate a pure transverse wave in a large area of a material to facilitate the analysis of the wavelength.

5.In vivo study

- In the second experiment, right calf of a healthy volunteer was examined in vivo.



Results



- The images acquired with bed-type oscillator show that the bed-type oscillator produces a flat wave in a large area of the calf.

6.Conclusion

- We realized the bed-type oscillator which produced a flat transverse wave in a large area of a material.
- The phantom experiment showed that the bed-type oscillator generated a flat wave.
- The human calf experiment in vivo showed that the bed-type oscillator propagated a flat transverse wave in a large area.

Future work

- Various parts of human body will be imaged with bed-type oscillator so as to realize quantitative measurement of elasticity.
- The direction of oscillation of the bed-type oscillator will be changed to generate a flat longitudinal wave for measurement of Youn g's modulus.

References

- Muthupillai R et al, ``Magnetic resonance elastography by direct visualization of propagating acoustic strain waves,'' SCIENCE, vol.269, pp.1854-1857, 1995