



ULTRASOUND CONTRAST MEDIA AGENTS



INTRODUCTION

- Contrast media extensively used in various imaging modalities.
- Ultrasound contrast agents (USCA) are now commercially available.



DEVELOPMENT

- Non-invasive reputation of US.
- Lack of effective and well tolerated compounds.
- Persistence increased using external stabilization and sugar matrix or encapsulation.



ADVANTAGES

- Do not exhibit allergic reactions or toxicity.
- Increased doppler signal intensity from
 - Vessels of deep location.
 - Small caliber.
 - Reduced or slow blood flow.
 - Vessels with anatomic limitations.



DEFINITION AND PROPERTIES

- An exogenous substance that can be injected inside blood pool or in human cavity or absorbed orally.
- Injected intravenously.
- Non-toxic.
- Stable for a sufficient amount of time.
- Strong non-linear resonance properties.



USCA's

- Optison - used in cases of blood flow measurement.
- SHU 563A- used for specific tissues like reticuloendothelial system.
- Galactose microparticles, Albumin-encapsulated bubbles, Renografin-76 are some other USCA's used in cardiac cases.



MICROBUBBLE BEHAVIOUR

- Injected as microbubbles.
- Generated by chemical action or mechanical agitation.
- Should have suitable size (less than 10 μ m) and suitable lifetime.
- Size to be maintained throughout imaging.
- Galactose microparticles – 3 μ m
- Suspended in carrier medium.



ULTRASOUND IMAGE SEQUENCES

- At acoustic pressures between 0.1-1 MPa u-bubbles start to resonate and produce harmonics.
- Resonant frequencies in range of medical interest.
- Harmonic imaging and pulse imaging sequences are used.
- Harmonic includes B-mode, color, spectral and power imaging.

ULTRASOUND IMAGE SEQUENCES

(cont..)

- In B-mode harmonic echoes from tissues are suppressed.
- In spectral harmonic clutter from vessel is rejected without any signal filtering.
- In color harmonic flash artifacts are reduced and smaller vessels can be detected.

ULTRASOUND IMAGE SEQUENCES

(cont..)

- At very high acoustic pressure ($> 1\text{MPa}$), u-bubbles are destroyed.
- They produce very short but strong echoes.
- It is imaged with help of Transient imaging and might be combined with harmonic imaging.
- Used for imaging renal cortex and liver parenchyma.

ULTRASOUND IMAGE SEQUENCES

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- However these techniques require further investigations in humans.
- As a result use of these USCA's is still suppressed.



VASCULAR APPLICATIONS

- Useful in differentiating sub-occlusion from occlusion in carotid artery diseases.
- Transcranial Doppler (TCD) is used for evaluation of intracranial cerebral arteries.
- USCA improves detection of intracranial stenosis and occlusion.
- USCA improves detection of circle of Willis, indicating severe stenosis of internal carotid artery.



VASCULAR APPLICATIONS (cont..)

- USCA is useful in detecting arteriovenous malformations and abnormal blood flow in brain tumors.
- USCA improves detection of blood flow in case of attenuation due to calcifications or prosthetic walls.



KIDNEY AND LIVER APPLICATIONS

- Renal artery stenosis is a major renal disorder, various imaging modalities, including spiral CT, MRI and angiography have been used as screening tests to detect the stenosis.
- Use of renal color Doppler US along with suitable USCA's provides a best cost and time effective test.

KIDNEY AND LIVER APPLICATIONS

(cont..)

- USCA's also give better signals in case of renal tumors and fistulas.
- With normal ultrasonography it is difficult to detect and characterize small masses, which is aided considerably by USCA's along with power mode.
- However they do not provide any information to differentiate between benign and malignant lesions.

KIDNEY AND LIVER APPLICATIONS

(cont..)

- Portal venous flow reduces largely due to liver atrophy, fat deposition or abdominal gases.
- Use of USCA increases Doppler signal of blood flow in portal vein.
- Blooming effect is reduced by adjusting certain settings.

KIDNEY AND LIVER APPLICATIONS

(cont..)

- Cells with hepatocarcinomas do not have Kupffer cells.
- USCA like SHU 563A are captured by Kupffer cells.
- High acoustic pressure applied.
- Signal detected using color Doppler.
- Hepatocarcinomas detected as color defects.



MISCELLANEOUS APPLICATIONS

- USCA are useful in detection of slow blood flow organs such as testis.
- USCA can be injected in uterus for study of Fallopian tubes.
- USCA such as LEVOVIST can also be used to detect vesico-renal reflux.

CONCLUSION

- Thus from all of the above discussion we can conclude that even if normal ultrasound technique is a non-invasive and easy modality, the use of ultrasound contrast agents can definitely provide better results. Even if these agents are non-toxic the only problem faced is the development of various techniques to image these agents better and development of agents having greater stability.

REFERENCES

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