Polyether Ether Ketone Cranioplasties Are Permeable to Diagnostic Ultrasound

Kay Mursch and Julianne Behnke-Mursch

Key words
- Cranial implant
- Craniectomy
- PEEK
- Reconstruction of the cranial vault
- Transcranial ultrasound
- Ultrasonography

Abbreviations and Acronyms
PEEK: Polyetheretherketone

Department of Neurosurgery, Zentralklinik, Bad Berka, Germany

To whom correspondence should be addressed: Kay Mursch, M.D. [E-mail: kaymu@yahoo.de; kay.mursch@zentralklinik.de]

Citation: World Neurosurg. (2018) 117:142-143. https://doi.org/10.1016/j.wneu.2018.06.064

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

It is a common assumption that the human skull and solid skull implants are impermeable to diagnostic ultrasound. We demonstrated in 2 patients that frontoparietal polyetheretherketone cranioplasties allowed useful imaging of intracranial parenchymal and vascular structures with higher ultrasound frequencies than the 2 MHz used for the temporal bone window.
This knowledge about additional imaging properties may be helpful in emergency situations and for vascular monitoring. The decision for a polyether ether ketone cranioplasty may contribute to patient safety.

With few exceptions, the human skull is impermeable to diagnostic ultrasound. Reflection and scattering impede diagnostic imaging.[1] The "acoustic window" for transcranial ultrasound is limited to a small variable area at the thin temporal bone.[2] However, it has been demonstrated in patients with sufficient bone windows that several questions can be answered at bedside or in the emergency setting and contribute to patient safety.[3,4] Thus a transparent bone would be an advantage for selected patients.

In 2 consecutive patients (**Figures 1-2**), we observed by chance that a polyetheretherketone (PEEK) implant of usual thickness of 4 mm (manufactured 3di GmbH, Jena, Germany) was transparent to ultrasound and allowed the use of higher ultrasound frequencies than the usual 2 MHz for the temporal bone. This results in a higher resolution in nearer distance.

An explanation of why PEEK is such an exceptional material may be the lack of internal echoes because of an exceedingly homogenous structure.

To conclude, it is possible to use an implant with comparable mechanical properties to other implant[5] but with the ability to allow ultrasound examinations.

When appropriate, for patients who are at risk for future vascular problems or hydrocephalus and require a cranial implant, PEEK may harbor advantages over other materials.

REFERENCES

1. Wijnhoud AD, Franckena M, van der Lugt A, Koudstaal PJ, Dippel ED. Inadequate acoustical temporal bone window in patients with a transient ischemic attack or minor stroke: role of skull thickness and bone density. *Ultrasound Med Biol.* 2008;34:923-929.
2. Aaslid R, Markwalder TM, Nornes H. Noninvasive transcranial Doppler ultrasound recording of flow velocity in basal cerebral arteries. *J Neurosurg.* 1982; 57:769-774.
3. Becker G, Bogdahn U, Strassburg HM, Lindner A, Hassel W, Meixensberger J, et al. Identification of ventricular enlargement and estimation of intracranial pressure by transcranial color-coded real-time sonography. *J Neuroimaging.* 1994;4:17-22.
4. Bogdahn U, Becker G, Winkler J, Greiner K, Perez J, Meurers B. Transcranial color-coded real-time sonography in adults. *Stroke.* 1990;21: 1680-1688.
5. Zanotti B, Zingaretti N, Verlicchi A, Robiony M, Alfieri A, Parodi PC. Cranioplasty: review of materials. *J Craniofac Surg.* 2016;27:2061-2072.

Conflict of interest statement: The author declares that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received 29 April 2018; accepted 10 June 2018

Citation: World Neurosurg. (2018) 117:142-143. https://doi.org/10.1016/j.wneu.2018.06.064

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

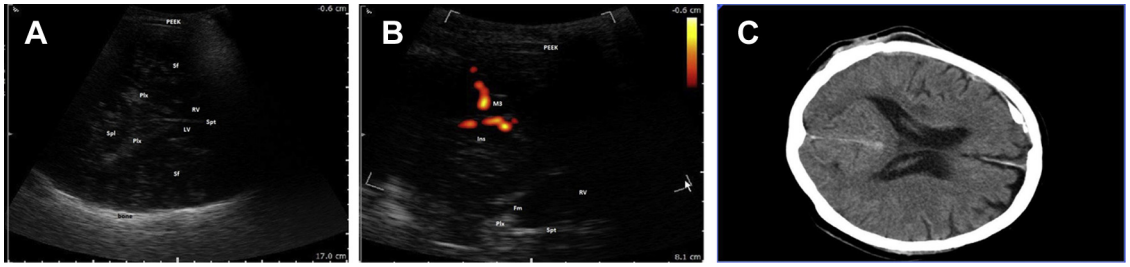

Figure 1. (**A**) Axial transcranial 3.5 MHz ultrasound images of a 51-year-old male who underwent removal of an autolytic bone flap and implantation of a calvarial polyetheretherketone (PEEK) implant 5 months ago. Several intracranial structures can be visualized through the cranioplasty: *bone* (contralateral frontal bone); left ventricle (*LV*); signal of the cranial implant (*PEEK*); plexus choroideus (*Plx*); right ventricle (*RV*); sylvia fissure (*Sf*); septum pellucidum (*Spt*); splenium corporis callosi (*Spl*). (**B**) Power Doppler image, same plane. (**C**) Cranial computed tomography, corresponding plane. Fm, foramen of Monroe; Ins, insula; M3, insular branches of the middle cerebral artery.

Figure 2. (**A**) Axial transcranial 2.5 MHZ ultrasound of a 47-year-old male 3 days after cranioplasty. Image plane through both cellae mediae. (**B**) Same plane, higher magnification. (**C**) Corresponding cranial computed tomography. Fm, foramen of Monroe; LV, left ventricle; PEEK, signal of the cranial implant; Plx, plexus choroideus; RV, right ventricle; Spt, septum pellucidum.