Ventriculo-amniotic shunt

Fetal aqueductal stenosis (AS) is one of the most common causes of congenital hydrocephalus, which increases intracranial pressure due to partial or complete obstruction of cerebrospinal fluid flow within the ventricular system. Approximately 2-4 infants per 10,000 births develop AS, which leads to progressive hydrocephalus, which enlarges the head often necessitating delivery by caesarean section. Most babies born with AS are severely neurologically impaired and experience a lifetime of disability. Therefore, a new device technology for ventriculo-amniotic shunting is urgently needed and has been studied to ameliorate or prevent fetal hydrocephalus development, which can provide a significant impact on patients and their family's quality of life and on the decrease of the healthcare dollars spent for the treatment.

Ventriculo-amniotic shunting is an option for the management of severe ventriculomegaly and results in normalization of the ventricular diameter. However, a high proportion of survivors have neurodevelopmental delay and the possible beneficial effect of ventriculo-amniotic shunting needs to be assessed by randomized studies [1)]

Many trials of intrauterine shunting proved unsuccessful, mainly because of complications such as intra- or extracranial shunt migration, obstruction, infection, and malposition.

Case report: The author is presenting a case of a successful ventriculo-amniotic shunt utilizing Al-Anazi ventriculo-uterine shunt, which is easy to implant. It has a one-way valve to prevent amniotic fluid backflow and special wings to prevent shunt migration, which is both relatively short and wide to reduce the possibility of malfunction and the risk of infection because there is no exposure to the external environment.

The successful trial showed that Al-Anazi ventriculo-uterine shunt might be the first step in treating congenital hydrocephalus [2)]

This study has successfully validated the design of shunt devices and demonstrated the mechanical performance and valve functions. A functional prototype shunt has been fabricated and subsequently used in multiple in vitro tests to demonstrate the performance of this newly developed ventriculoamniotic shunt. The shunt contains a main silicone-nitinol composite tube, a superelastic 90° angled dual dumbbell anchor, and an ePTFE valve encased by a stainless-steel cage. The anchor will change its diameter from 1.15 mm (collapsed state) to 2.75 mm (deployed state) showing up to 1.4-fold diameter change in human body temperature. Flow rates in shunts were quantified to demonstrate the valve function in low flow rates mimicking the fetal hydrocephalus condition showing “no backflow” for the valved shunt while there is up to 15 mL/h flow through the shunt with pressure difference of 20 Pa. In vivo ovine study results show the initial successful device delivery and flow drainage with sheep model [3)].

Case reports

Clewell WH, Johnson ML, Meier PR, Newkirk JB, Hendee RW Jr, Bowes WA Jr, Zide SL, Hecht F, Henry G, O'Keeffe D. Placement of ventriculo-amniotic shunt for hydrocephalus in a fetus. N Engl J Med. 1981 Oct 15;305(16):955. doi: 10.1056/NEJM198110153051615. PMID: 7278901.

1)

Litwinska M, Litwinska E, Czaj M, Polis B, Polis L, Szaflik K. Ventriculo-amniotic shunting for severe fetal ventriculomegaly. Acta Obstet Gynecol Scand. 2019 Sep;98(9):1172-1177. doi: 10.1111/aogs.13622. Epub 2019 May 9. PMID: 30977122.

2)

Al-Anazi A, Al-Mejhim F, Al-Qahtani N. In uteroventriculo-amniotic shunt for hydrocephalus. Childs Nerv Syst. 2008 Feb;24(2):193-5. doi: 10.1007/s00381-007-0451-1. Epub 2007 Sep 18. PMID: 17876591.

3)

Emery SP, Greene S, Elsisy M, Chung K, Ye SH, Kim S, Wagner WR, Hazen N, Chun Y. In vitro and in vivo assessment of a novel ultra-flexible ventriculoamniotic shunt for treating fetal hydrocephalus. J Biomater Appl. 2022 Sep 5:8853282221125309. doi: 10.1177/08853282221125309. Epub ahead of print. PMID: 36063383.