Hydrocephalus caused by unilateral foramen of Monro obstruction: A review on terminology

Flavio Nigri¹,², Gabriel Neffa Gobbi¹, Pedro Henrique da Costa Ferreira Pinto¹, Elington Lannes Simões¹, Egas Moniz Caparelli-Daquer²,³

¹Department of Surgical Specialties, Neurosurgery Teaching and Assistance Unit, Pedro Ernesto University Hospital, Rio de Janeiro State University, ²Nervous System Electric Stimulation Laboratory (LabEEL) - Neurosurgery Teaching and Assistance Unit, Pedro Ernesto University Hospital, Rio de Janeiro State University, ³Physiological Sciences Department, Roberto Alcântara Gomes Biology Institute, Rio de Janeiro State University, Rio de Janeiro, RJ, Brazil

E-mail: *Flavio Nigri - flavionigri@gmail.com; Gabriel Neffa Gobbi - gabrielgobbi@hotmail.com; Pedro Henrique da Costa Ferreira Pinto - pedrohcfp@gmail.com; Elington Lannes Simões - elington.lannes@gmail.com; Egas Moniz Caparelli-Daquer - egas.caparelli@gmail.com
*Corresponding author

Received: 09 December 15   Accepted: 16 February 16  Published: 13 May 16

Abstract

Background: Hydrocephalus caused by unilateral foramen of Monro (FM) obstruction has been referred to in literature by many different terminologies. Precise terminology describing hydrocephalus confined to just one lateral ventricle has a very important prognostic value and determines whether or not the patient can be shunt free after an endoscopic procedure.

Methods: Aiming to define the best term for unilateral FM obstruction, 19 terms were employed on PubMed database (http://www.ncbi.nlm.nih.gov/pubmed) as quoted phrases.

Results: A total of 194 articles were found. Four patterns of hydrocephalus were discriminated as a result of our research term query and were divided by types for didactic purpose. Type A - partial dilation of the lateral ventricle; Type B - pure unilateral obstruction of the FM; Type C - previously shunted patients with secondary obstruction of the FM; and Type D - asymmetric lateral ventricles with patent FM.

Conclusion: In unilateral FM obstruction hydrocephalus, an in-depth review on terminology application is critical to avoid mistakes that may compromise comparisons among different series. This terminology review suggests that Type B hydrocephalus, i.e., the hydrocephalus confined to just one lateral ventricle with no other sites of cerebrospinal fluid circulation blockage, are best described by the terms unilateral hydrocephalus (UH) and monoventricular hydrocephalus, the first being by far the most popular. Type A hydrocephalus is best represented in the literature by the terms uniloculated hydrocephalus and loculated ventricle; Type C hydrocephalus by the terms isolated lateral ventricle and isolated UH; and Type D hydrocephalus by the term asymmetric hydrocephalus.

Key Words: Foramen of Monro, isolated lateral ventricle, monoventricular hydrocephalus, unilateral hydrocephalus

How to cite this article: Nigri F, Gobbi GN, da Costa Ferreira Pinto PH, Simões EL, Caparelli-Daquer EM. Hydrocephalus caused by unilateral foramen of Monro obstruction: A review on terminology. Surg Neurol Int 2016;7:S307-13. http://surgicalneurologyint.com/Hydrocephalus-caused-by-unilateral-foramen-of-Monro-obstruction-A-review-on-terminology/
INTRODUCTION

Unilateral ventricle dilation, unrelated to ex-vacuum hemisphere atrophy, is caused by unilateral foramen of Monro (FM) obstruction. It may be just an obstructed compartment within a more complex hydrocephalus or a unique compartment with hydrocephalus. Hydrocephalus caused by unilateral FM obstruction has been referred to in literature by many different terms. Precise terminology describing hydrocephalus confined to just one lateral ventricle has a very important prognostic value and determines whether or not the patient can be shunt free after endoscopic procedure. Here, we discuss terminology for unilateral FM obstruction hydrocephalus based on literature review.

METHODS

The terms asymmetric hydrocephalus (AH), asymmetric lateral ventricle, asymmetric lateral ventricles, asymmetric ventricle, asymmetric ventricles, compartmentalized hydrocephalus, isolated lateral ventricle (ILV), isolated unilateral hydrocephalus (IUH), isolated ventricle, isolated ventricles, loculated hydrocephalus, loculated lateral ventricle, loculated ventricle (LV), monoventricular hydrocephalus (MH), trapped lateral ventricle, trapped ventricle, UH, unilateral ventriculomegaly, and uniloculated hydrocephalus (ULH) were employed on PubMed database (http://www.ncbi.nlm.nih.gov/pubmed) as quoted phrases. Only articles with clear described cases were selected. Review articles were excluded. Only human articles were considered. Bilateral FM obstruction articles were not included.

RESULTS

A total of 194 articles were found [Table 1]. As depicted on Figure 1, four general patterns of hydrocephalus were discriminated as a result of our research terms query and were divided by types for didactic purpose. Type A - partial dilation of the lateral ventricle, i.e., ventricular septa, ventricular cyst, or trigone obstruction; Type B - unilateral obstruction of the FM; Type C - previously shunted patients with secondary obstruction of the FM; and Type D - hydrocephalus with asymmetric lateral ventricles and patent FM.

DISCUSSION

The best term for pure unilateral FM obstruction shall be specific to describe hydrocephalus of the lateral ventricles at the foramina level and at the same time shall not be used to describe heart ventricles. The terms asymmetric lateral ventricle, asymmetric ventricle, loculated lateral ventricle, and trapped lateral ventricle disclosed no result [Table 1]. The terms isolated ventricle and isolated ventricles are also used to describe heart ventricle disease [Table 1]. The terms compartmentalized hydrocephalus, loculated hydrocephalus, and trapped ventricle although specific to brain ventricles are not specific for lateral ventricle involvement [Table 1]. The terms asymmetric lateral ventricles, asymmetric ventricles, and unilateral ventriculomegaly not always describe hydrocephalus [Table 1]. Then these terms did not seem appropriate for further discussion.

Obstruction of the FM causing dilation of ipsilateral ventricle admits several etiologies. It may be the single component of the hydrocephalus, or it may also be associated with other sites of cerebrospinal fluid (CSF) circulation blockage. Among all terms applied, the terms AH, ILV, IUH, LV, MH, UH, and ULH have shown to describe hydrocephalus of the lateral ventricles and not heart ventricles [Table 1]. For this reason, these terms were chosen for further discussion [Table 2].

Asymmetric hydrocephalus

The term AH literally means the coexistence of hydrocephalus with asymmetric ventricles. It can occur in patients with hydrocephalus and different size ventricles caused by congenital or acquired unilateral...
brain atrophy. Durée et al., reserve the term AH for cases where asymmetrical dilation of the lateral ventricles has more than 2 mm, thus including patients sustaining bilateral and unilateral ventricular ectasia. According to the literature, AH can mean any type of hydrocephalus depicted in Figure 1. Although it can be used to describe hydrocephalus caused by postshunt FM obstruction, it does not exclude cases with patent FM. [10,46]

Isolated lateral ventricle

The term ILV literally means that the whole lateral ventricle is isolated from the rest of the ventricular system, including cases where patients also have other sites of CSF circulation obstruction. The literature review has shown that ILV has been employed to designate communicating hydrocephalus associated with postshunt FM obstruction, pure lateral ventricle hydrocephalus, and also combining the two conditions. Krucoff et al. used the term ILV as a UH synonym. [48]

Table 1: Literature review listing terminology as quoted phrases; number of articles found (n); ventricles involved in terminology description; if the term always described cases with hydrocephalus; and if the terms are used to describe heart ventricles

| Terminology (quoted phrase) | n | Ventricles involved | Term always referred to hydrocephalus? | Term used for heart ventricles |
|-----------------------------|---|---------------------|----------------------------------------|-------------------------------|
| AH                          | 10 | Lateral             | Yes                                    | No                            |
| Asymmetric lateral ventricle| 0  | -                   | -                                      | -                            |
| Asymmetric ventricle        | 4  | Lateral             | No                                     | No                            |
| Asymmetric ventricles       | 0  | -                   | -                                      | -                            |
| Compartmentalized hydrocephalus | 4 | Lateral and IV | Yes                                    | No                            |
| ILV                         | 9  | Lateral             | Yes                                    | No                            |
| IUH                         | 4  | Lateral             | Yes                                    | No                            |
| Isolated ventricle          | 14 | Lateral and IV | No                                      | Yes                           |
| Isolated ventricles         | 11 | Lateral and IV | No                                      | Yes                           |
| Loculated hydrocephalus     | 15 | Lateral, Ill and IV | Yes                                    | No                            |
| Loculated lateral ventricle | 0  | -                   | -                                      | -                            |
| LV                          | 2  | Lateral             | Yes                                    | No                            |
| MH                          | 6  | Lateral             | Yes                                    | No                            |
| Trapped lateral ventricle   | 0  | -                   | -                                      | -                            |
| Trapped ventricle           | 3  | Lateral and IV | Yes                                    | No                            |
| UH                          | 73 | Lateral             | Yes                                    | No                            |
| Unilateral ventriculomegaly | 25 | Lateral             | No                                     | No                            |

AH: Asymmetric hydrocephalus, ILV: Isolated lateral ventricle, IUH: Isolated unilateral hydrocephalus, MH: Monoventricular hydrocephalus, UH: Unilateral hydrocephalus, ULH: Uniloculated hydrocephalus, LV: Loculated ventricle

Table 2: Literature review listing terminology, type of hydrocephalus as depicted in Figure 1, and authors’ affiliation country

| Author and year             | Terminology | Type        | Country   |
|-----------------------------|-------------|-------------|-----------|
| Abdel-Salam et al. 2011     | AH          | D           | Egypt     |
| Atalay et al. 2006          | AH          | C           | Turkey    |
| Bhattacharyya et al., 2010  | AH          | A           | India     |
| Durfee et al. 2001          | AH          | B + D       | USA       |
| Kehler et al. 1997          | AH          | B + C       | Germany   |
| Ang et al. 2006             | ILV         | C           | Canada    |
| Hamada et al. 2003          | ILV         | B + C       | Japan     |
| Hubballah and Hoffman 1987  | ILV         | C           | Canada    |
| Krucoff et al. 2015         | ILV         | B           | USA       |
| Schulz et al. 2013          | ILV         | C           | Germany   |
| Steinbok et al. 1994        | ILV         | C           | Canada    |
| Hayashi et al. 1990         | IUH         | C           | Japan     |
| Oi et al. 1999              | IUH         | C           | Japan     |
| Oi and Enchev 2008          | IUH         | B           | Japan     |
| Salmon 1970                | IUH         | C           | USA       |
| Oi et al. 1999              | LV          | A           | Japan     |
| Schlitt et al. 1986         | LV          | A           | USA       |
| Abderrahmen et al. 2008     | MH          | B           | Tunisia   |
| Alonso et al. 1979          | MH          | B           | Spain     |
| Cai et al. 2013             | MH          | B           | China     |
| Freppel et al. 2009         | MH          | B           | France    |
| Gangemi et al. 1999         | MH          | B + C       | Italy     |
| Alexander and Botteroll 1949| UH          | B           | USA       |
| Anderson et al. 1993        | UH          | B           | New Zeland|
| Aydin et al. 2007           | UH          | B           | Turkey    |
| Baumann et al. 1982         | UH          | B           | Israel    |
| Bhagwati 1964              | UH          | B           | USA       |
| Boyar et al. 1993           | UH          | B           | Turkey    |
| Brück et al. 1991           | UH          | A           | Germany   |
| Burtscher et al. 2003       | UH          | B           | Germany   |
| Cantini et al. 1980         | UH          | C           | Italy     |
| Chang et al. 1991           | UH          | B           | USA       |
| Chun et al. 2011            | UH          | B           | South Africa|
| Dastgir et al. 2006         | UH          | B           | Saudi Arabia|
| de Vries et al. 2000        | UH          | B           | The Netherlands|
| Decq et al. 1994            | UH          | B           | France    |
| Dorvling-Carter et al. 1987 | UH          | B           | France    |
| Fondop et al. 2010          | UH          | B           | France    |
| Gaston and Jones 1989      | UH          | B           | USA       |
| Greenlee et al. 2008        | UH          | B           | USA       |
| Hageman et al. 1985         | UH          | B           | The Netherlands|
| Hongo et al. 2001           | UH          | B           | Japan     |
| Husag et al. 1976           | UH          | B           | German    |
| Ismail et al. 2001          | UH          | B           | Kuwait    |
| Ito et al. 1978             | UH          | B           | Japan     |
| Jeon et al. 2005            | UH          | B           | Korea     |
| Jivan et al. 2010           | UH          | B           | South Africa|
| Kasantikul et al. 1987      | UH          | B           | Thailand  |

Contd...
Isolated unilateral hydrocephalus

The term IUH has been used to indicate that the hydrocephalus is confined to one brain side including complete or partial lateral ventricle dilation. In the literature, this term specifically refer to FM obstruction, but it is employed in situations when hydrocephalus is restricted\(^{66}\) and also when not restricted\(^{67,64,69}\) to the lateral ventricle [Table 2].

Loculated ventricle

The term LV literally describes a compartment separated from the rest of the ventricular system. It has been applied on situations where there is a partial dilation of the lateral ventricle, like Type A depicted on Figure 1.\(^{64,70}\)

Monoventricular hydrocephalus

The term MH specifically defines a single lateral ventricle obstruction that by anatomical reasons can only indicate the involvement of the lateral ventricle, inasmuch as an obstruction of the third ventricle or fourth ventricles will necessarily cause biventricular and triventricular hydrocephalus respectively. Indeed, the term MH has been used to describe hydrocephalus restricted to one lateral ventricle, as shown in four articles [Table 3]. However, Gangemi et al. included cases with FM obstruction associated with communicating hydrocephalus.\(^{32}\) Furthermore, there is a logical preference for terms describing the number of ventricles involved, such as monoventricular, biventricular, triventricular, and tetraventricular hydrocephalus, as described in Mori and Raimondi’s classification of hydrocephalus.\(^{80}\) Cultural influence seems to play an important role in terminology choice. Eighty percent of articles using the term MH come from Latin language speaking countries [Table 4].

Unilateral hydrocephalus

The term UH literally means that the hydrocephalus is confined to one brain side. It may indicate a complete or partial dilation of the lateral ventricle. Probably due to the universal use of English language [Table 4] the term UH is by far the most commonly employed in Type B hydrocephalus [Figure 1] as shown in fifty articles [Table 3]. However, it has also been employed through literature in different types of hydrocephalus [Table 3]. Brück et al.,\(^{16}\) and Takeshita et al.,\(^{78}\) used the term UH not describing FM obstruction, but in cases with partial dilation of the lateral ventricle. Cantini et al.,\(^{19}\) and Lazareff and Sadowinski,\(^{13}\) used the term UH for cases of hydrocephalus not restricted to the lateral ventricle. Nishizaki et al., described a case of biventricular hydrocephalus, which he designated left dominant UH.\(^{60}\) Hageman et al., described an arthrogryposis newborn with left lateral ventricle dilation, midline shift, asymmetric head, and right hemiparesis.\(^{35}\) Although it may be considered a case of UH, the abnormality was diagnosed as unilateral cerebral hypoplasia, so no treatment was indicated. Suzuki et al. described a case of unilateral hydranencephaly and named it UH.\(^{77}\) The term bilateral hydrocephalus, albeit employing the same terminological criteria as UH, is not frequently employed.

Uniloculated hydrocephalus

The term ULH literally means that a ventricle is compartmentalized or is by itself a unique hydrocephalic compartment. El-Ghandour,\(^{28}\) and Lewis et al.,\(^{55}\) use the term ULH as a general term describing cases with partial dilation of the lateral ventricle, complete dilation of one lateral ventricle, and shunt complicated unilateral FM obstruction. Nowoslawska et al., use to describe a pure FM obstruction case [Table 2].\(^{64}\) Andresen and
Table 3: Number of articles matching terminology (rows) with type of the hydrocephalus as depicted in Figure 1 (columns)

| Term Meaning | AH | ILV | IUH | LV | MH | UH | ULH |
|--------------|----|-----|-----|----|----|----|-----|
| Type A       |    |     |     |    |    |    |     |
| Type B       |    |     |     |    |    |    |     |
| Type C       |    |     |     |    |    |    |     |
| Type D       |    |     |     |    |    |    |     |

Table 4: Distribution of terms appearing in articles dealing with foramen of Monro obstruction by country (from articles listed in Table 2)

| Country       | Total | AH | ILV | IUH | LV | MH | UH | ULH |
|---------------|-------|----|-----|-----|----|----|----|-----|
| Brazil        | 1     | 0  | 0   | 0   | 0  | 1  | 0  |     |
| Canada        | 3     | 0  | 3   | 0   | 0  | 0  | 0  |     |
| China         | 1     | 0  | 0   | 0   | 0  | 1  | 0  |     |
| Denmark       | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| Egypt         | 2     | 1  | 0   | 0   | 0  | 0  | 0  | 1   |
| France        | 5     | 0  | 0   | 0   | 0  | 0  | 0  | 0   |
| Germany       | 7     | 1  | 1   | 0   | 0  | 0  | 0  | 0   |
| India         | 7     | 1  | 0   | 0   | 0  | 0  | 0  | 0   |
| Iran          | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| Israel        | 2     | 0  | 0   | 0   | 0  | 0  | 0  | 2   |
| Italy         | 2     | 0  | 0   | 0   | 0  | 0  | 0  | 2   |
| Japan         | 15    | 0  | 1   | 3   | 1  | 0  | 10  | 0   |
| Korea         | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| Kuwait        | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| Mexico        | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| The Netherlands | 2     | 0  | 0   | 0   | 0  | 0  | 0  | 2   |
| New Zealand   | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| Poland        | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| Saudi Arabia  | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| Serbia        | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| South Africa  | 2     | 0  | 0   | 0   | 0  | 0  | 0  | 2   |
| Spain         | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 0   |
| Switzerland   | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| Thailand      | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| Tunisia       | 1     | 0  | 0   | 0   | 0  | 0  | 0  | 1   |
| Turkey        | 3     | 1  | 0   | 0   | 0  | 0  | 0  | 2   |
| USA           | 17    | 1  | 1   | 1   | 1  | 0  | 12  | 1   |

AH: Asymmetric hydrocephalus, ILV: Isolated lateral ventricle, IUH: Isolated unilateral hydrocephalus, MH: Monoventricular hydrocephalus, UH: Unilateral hydrocephalus, ULH: Uniloculated hydrocephalus, LV: Loculated ventricle

Table 3: Number of articles matching terminology (rows) with type of the hydrocephalus as depicted in Figure 1 (columns)

Juhler, proposed a very practical classification dividing hydrocephalus in loculations and its variants. [6] Loculated hydrocephalus is a condition in which discrete fluid-filled compartments form in or in relation to the ventricular system of the brain. [6] Applying Andresen and Juhler, classification in FM obstruction situations, pure FM obstruction [Figure 1, Type B] is termed “simple uniloculated hydrocephalus” and FM obstruction associated with communicating hydrocephalus [Figure 1, Type C] is classified as “complex uniloculated hydrocephalus.” [6]

Term meaning X application in the literature

Table 5 depicts the comparison of the literal meaning of a terminology and how this term is used in the literature. All the terms show a strong correlation between terminology meaning and application in the literature, but there is some misuse that may cause confusion.

Endoscopic treatment of unilateral foramen of Monro obstruction hydrocephalus

Since 1994, endoscopy is the treatment of choice for Type A, Type B, and Type C hydrocephalus. [7,11,17,18,21,25,30-32,34,36,38,43,44,49,50,52,58,63,64,71,73,75,82,84,87] Many endoscopic techniques have been employed with high success rates such as septostomy, [7,11,17,18,21,25,30-32,34,36,38,43,44,49,50,52,58,63,64,71,73,75,82,84,87] open membranes, [11,13,34,58] lesion removal, [56,43,44,84] Mono foraminoplasty, [21,48,50,65,68] and cyst fenestration. [31,32] Some authors still prefer standard methods like shunt, [21,47,72,80] open craniotomy lesion removal and shunt, [85] and Rickham reservoir and shunt. [24] Endoscopic technique to communicate ventricular compartments is not indicate for Type D hydrocephalus where both FM are patent. On Type B hydrocephalus, patients are shunt free after endoscopic treatment of hydrocephalus. [2,11,17,18,21,23,32,34,36,38,43,44,49,50,52,38,75,82,84,87] On Type C hydrocephalus, the endoscopic technique is employed to avoid a second shunt implantation, and the patient remains shunt-dependent. [7,32,64,73]

CONCLUSION

This study indicates that, in unilateral FM obstruction hydrocephalus, a thorough review of the terminology application is critical to avoid mistakes that may compromise comparisons among different series. There are different terminologies meaning the same and also cases where the same terminology is applied for different clinical situations. This terminology review suggests that Type B hydrocephalus, i.e., the hydrocephalus confined to just one lateral ventricle with no other sites of CSF circulation blockage, are best described by the terms UH and MH hydrocephalus, the first being by far the most popular. Type A hydrocephalus is best represented in the literature by the terms ULH and LV, Type C hydrocephalus by the term AH.
Table 5: Comparison of the term meaning and its application in the literature

| Literally meaning by type | Literature usage by type (%) |
|--------------------------|-----------------------------|
| AH A, B, C, D            | A (14), B (29), C (29), D (29) |
| ILV B, C                | B (29), C (71)              |
| IUH A, B                | B (25), C (75)              |
| LV A, B, C              | A (100)                     |
| MH B                    | B (83), C (17)              |
| UH A, B                 | A (4), B (89), C (4), D (4) |
| ULH A, B                | A (17), B (50), C (33)      |

The type of hydrocephalus is depicted on Figure 1. AH: Asymmetric hydrocephalus, ILV: Isolated lateral ventricle, IUH: Isolated unilateral hydrocephalus, MH: Monoventricular hydrocephalus, UH: Unilateral hydrocephalus, ULH: Uniloculated hydrocephalus.

Financial support and sponsorship
Authors received FAPERJ financial support

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Abdel-Salam GM, Flores-Sarnat L, El-Ruby MO, Parboosingh J, Bridge P, Eid MM, et al. Muenke syndrome with pigmentary disorder and probable hemimegalencephaly: An expansion of the phenotype. Am J Med Genet A 2011;155A:207-14.
2. Abderrahmen K, Aouidj ML, Kallel J, Zammel I, Khaldi MM. Hydrocephalus due to non tumoral stenosis of foramen of Monro: Report of four cases. Neurochirurgie 2008;54:72-8.
3. Alexander E Jr., Botterell EH. Unilateral hydrocephalus resulting from occlusion of foramen of Monro: complication of radical removal of brain abscess. J Neurosurg 1949;6:197-206.
4. Alonso A, Taboada D, Alvarez JA, Paramo C, Vila M. Spontaneous ventriculostomy and ventricular diverticulum. Radiology 1979;133(3 Pt 1):651-4.
5. Anderson N, Malpas T, Davison M. Prenatal diagnosis of unilateral hydrocephalus. Pediatr Radiol 1993;23:69-70.
6. Andresen M, Juhler M. Multiloculated hydrocephalus: A review of current problems in classification and treatment. Childs Nerv Syst 2012;28:357-62.
7. Ang BT, Steinbok P, Cochrane DD. Etiological differences between the isolated lateral ventricle and the isolated fourth ventricle. Childs Nerv Syst 2006;22:1080-5.
8. Aronyk KE. The history and classification of hydrocephalus. Neurosurg Clin N Am 1993;4:599-609.
9. Atad-Rapoport M, Schweiger A, Lev D, Sadan-Strul S, Malinger G, Lerman-Sagie T. Neuropsychological follow-up at school age of children with asymmetric ventricles or unilateral ventriculomegaly identified in utero. BJOG 2015;122:932-8.
10. Atalay B, Yilmaz C, Cekinmez M, Altnors N, Caner H. Treatment of hydrocephalus with functionally isolated ventricles. Acta Neurochir (Wien) 2006;148:1293-6.
11. Aydin K, Cokluk C, Golce E, Diren B, Ilygun O, Rakunt C, et al. Use of 3DFT-CISS sequences and virtual MR endoscopy for the neuroendoscopic treatment of unilateral hydrocephalus: Case illustration. Minim Invasive Neurosurg 2007;50:239-42.
12. Baumann B, Danon L, Weitz R, Blumensohn R, Schonfeld T, Nitzan M. Unilateral hydrocephalus due to obstruction of the foramen of Monro: Another complication of intrauterine mumps infection? Eur J Pediatr 1982;139:158-9.
13. Bhagwati S. A case of unilateral hydrocephalus secondary to occlusion of one of the foramen of Monro. J Neurol Surg 1964;21:226-9.
14. Bhattacharyya A, Boruah DK, Handique A, Singh V, Kalita J, Misra UK, et al. Involvement of the choroid plexus in neurotuberculosis. MR findings in six cases. Neuroradiol J 2010;23:590-5.
15. Boyar B, Ildan F, Bagdatoglu H, Cetinap E, Karadayi A. Unilateral hydrocephalus resulting from occlusion of foramen of Monro: A new procedure in the treatment: Stereotactic fenestration of the septum pellucidum. Surg Neurol 1993;39:110-4.
16. Brück W, Sander U, Blankenberg P, Friesle R. Symptomatic xanthogranuloma of choroid plexus with unilateral hydrocephalus. Case report. J Neurol 1991;275:324-7.
17. Burtscher J, Sweeney R, Balle R, Eisein W, Twery K. Neuroendoscopy based on computer assisted adjustment of the endoscope holder in the laboratory. Minim Invasive Neurosurg 2003;46:208-14.
18. Cai Q, Song P, Chen Q, Chen Z, Huang S, Xu H, et al. Neuroendoscopic fenestration of the septum pellucidum for monoventricular hydrocephalus. Clin Neurol Neurosurg 2013;115:976-80.
19. Cantini R, Lenzi B, Meezo A. Ventriculo-atrial shunt (delayed unilateral hydrocephalus). J Neurosurg Sci 1980;24:45-50.
20. Chang Y, Horoupian DS, Lane B, Fross RD, Smyth LT Jr., Seiling RJ. Inflammatory pseudotumor of the choroid plexus in Sjögren’s disease. Neurosurgery 1999;29:287-90.
21. Chun HJ, Lee Y, Park HK, Kim YS. Neuroendoscopic fenestration of the foramen of Monro without septostomy for unilateral hydrocephalus following neonatal intraventricular hemorrhage. Childs Nerv Syst 2011;27:473-8.
22. Dandy WE. Experimental hydrocephalus. Ann Surg 1919;70:129-42.
23. Dastgir G, Awaal A, Salam A, Atitz A. Unilateral hydrocephalus due to foramen of Monro stenosis. Minim Invasive Neurosurg 2006;49:184-6.
24. de Vries LS, Groenendaal F, Gooskens R, Hanlo P. Unilateral posthaemorrhagic hydrocephalus in the neonatal period or later in infancy. Acta Paediatr 2000;89:77-81.
25. Deq P, Yepes C, Anno Y, Djindjian M, Nguyen JP, Kéavel Y. Neurosurgical endoscopy. Diagnostic and therapeutic indications. Neurochirurgie 1994;40:313-21.
26. Dowling-Carter D, Scherpereel B, Baudrillard JC, Omez F, Lejeune JP, Rousseaux P, et al. Unilateral non-tumor hydrocephalus in children. Areasia of the foramen of Monro? Neurochirurgie 1987;33:129-34.
27. Duurfee SM, Kim FM, Benson CB. Postnatal outcome of fetuses with the prenatal diagnosis of asymmetric hydrocephalus. J Ultrasound Med 2001;20:263-8.
28. El-Ghandour NM. Endoscopic cyst fenestration in the treatment of uniloculated hydrocephalus in children. J Neurosurg Pediatr 2013;11:402-9.
29. Ferreira M, Nahed BV, Babu MA, Walcott BP, Ellenbogen RG, Sekhar LN. Trapped fourth ventricle phenomenon following aneurysm rupture of the posterior circulation: Case reports. Neurosurgery 2012;70:E253-8.
30. Fondop J, Lagmari M, Metellus P, Fuentes S, Ngh E, Djenchieu V, et al. Unilateral hydrocephalus secondary to a brain temporal abscess treated by endoscopic septotomy: A case report. Neurochirurgie 2010;56:337-9.
31. Freppel S, Marchal JC, Joud A, Pinelli C, Klein O. Early surgical management of antenatal diagnosed cysts of the foramen of Monro causing monoventricular hydrocephalus. Childs Nerv Syst 2009;25:S131-5.
32. Gangemi M, Maiuri F, Donati PA, Signorelli F, Basile D. Endoscopic surgery for monoventricular hydrocephalus. Surg Neurol 1999;52:246-50.
33. Gaston BM, Jones BE. Perinatal unilateral hydrocephalus. Atresia of the foramen of Monro. Pediatr Radiol 1989;19:328-9.
34. Greenlee JD, Teo C, Ghahreman A, Kwok B. Purely endoscopic resection of colloid cysts. Neurosurgery 2008;62 3 Suppl I:51-5.
35. Hageman G, Gooskens RH, Willemsje E. A cerebral cause of arthrogryposis: Unilateral cerebral hypoplasia. Clin Neurol Neurosurg 1985;87:119-22.
36. Hamada H, Hayashi N, Kurimoto M, Umemura K, Hirashima Y, Endo S. Neuroendoscopic septostomy for isolated lateral ventricle. Neurol Med Chir (Tokyo) 2003;43:582-7.
37. Hayashi T, Hashimoto T, Fukuda S, Anegawa S, Torigoe R. Clinical analysis of shunted hydrocephalic neonates and sucklings. Observation of postshunt complication due to overdrainage from intraventricular CSF. No To Shinkei 1990;42:167-71.
38. Hongo K, Morota N, Watabe T, Isobe M, Nakagawa H. Giant basilar bifurcation aneurysm presenting as a third ventricular mass with unilateral obstructive hydrocephalus: Case report. J Clin Neurosci 2001;8:51-4.
39. Hubballah MT, Hoffman HJ. The isolated lateral ventricle. Experience at the hospital for sick children. Surg Neurol 1987;27:220-2.
40. Husz L, Wieser HG, Probst C. Unilateral hydrocephalus due to membranous...
occlusions of the foramen of Monro (author's trans). Acta Neurochir (Wien) 1976;33:183-212.

41. Issam EA, Shafik MH, Al-Mutairi G. A case of non-D-O:1 Vibrio cholerae septicaemia with meningitis, cerebral abscess and unilateral hydrocephalus in a preterm baby. Eur J Clin Microbiol Infect Dis 2001;20:598-600.

42. Ito M, Ishikawa S, Ono Y, Akiyama I. Unilateral hydrocephalus associated with congenital hemihypertrophy. Neurol Med Chir (Tokyo) 1978;18(1 Pt 1):49-57.

43. Jeon JH, Lee SW, Ko JK, Choi BG, Cha SH, Song GS, et al. Neuroendoscopic removal of large choroid plexus cyst: A case report. J Pediatr Neurosurg 2005;20:335-9.

44. Jivan K, Mochan A, Modi G. Intraventricular neuroendoscopy due to an intraventricular venous malformation obstructing the foramen of Monro. Afr J Psychiatry (Johannesburg) 2010;13:315-7.

45. Kasatnikul V, Shuangshoti S, Taecholarn C. Primary pycomycosis of the brain in heroin addicts. Surg Neurol 1987;28:468-72.

46. Kehler U, Gliemroth J, Arnold H. Asymmetric hydrocephalus: Safe endoscopic fenestration of septum pellucidum: Technical note. Minim Invasive Neurosurg 1997;40:101-2.

47. Koga Y, Tahara Y, Kida T, Matsumoto Y, Negishi H, Fujimoto S. Prenatal diagnosis of congenital unilateral hydrocephalus. Pediatr Radiol 1997;27:319-20.

48. Krakoff MO, Chinn M, Babington P, Litvak ZN. Controversial neuroendoscopic Foraminal Monaforoplasty in the management of isolated lateral ventricle in an adult. Interdisciplinary Neurosurgery: Advanced Techniques and Case Management 2015;2:108-10.

49. Kumar R, Bhagat P. A severe and rapidly progressive case of prostatic syndrome in a neonate who presented with unilateral hydrocephalus apart from other typical features of the prostates syndrome. J Clin Neonatol 2012;1:152-4.

50. Kumar R. Unilateral hydrocephalus in paediatic patients, a trial of endoscopic fenestration. Neurol India 1999;47:282-5.

51. Lazareff JA, Sadowski S. The probable role of hydrocephalus in the development of intraventricular septa. An observation of one case. Childs Nerv Syst 1992;8:139-41.

52. Leonardo J, Grand W. Enlarged thalamostriate vein causing unilateral Monro foraminoplasty in the management of isolated lateral ventricle in children. Childs Nerv Syst 2003;19:659-65.

53. Lim WA, Ong JL, Tzioumis A, Zada M, Sibinga C, Tan AA, et al. Long-term follow-up. Surg Neurol Int 2011;2:141.

54. Mampalam TJ, Harsh GR 4th, Tien RD, Dillon WP, Wilson CB. Unilateral hydrocephalus in adults. Surg Neurol 1991;35:14-9.

55. Meadows J, Pigula F, Lock J, Marshall A. Transcatheter creation and enlargement of ventricular septal defects for relief of ventricular hypertension. J Thorac Cardiovasc Surg 2007;133:912-8.

56. Milhorat TH, Hammock MK, Breckbill DL. Acute unilateral hydrocephalus resulting from oedematous occlusion of foramen of Monro: Complication of intraventricular surgery. J Neurosurg 1975;38:745-8.

57. Miyahara N, Saito Y, Tabuchi S, Watanabe T, Maegaki Y, Ohno K. Unilateral hydrocephalus due to idiopathic anomaly of foramen of Monro, treated successfully with endoscopic technique. Report of three cases. Cent Eur Neurosurg 2010;71:143-6.

58. Singh DK, Rastogi M, Sharma A, Husain M. Unilateral hydrocephalus: Atypical presentation of intracranial tuberculoma. Turk Neurosurgery 2011;21:242-5.

59. Steinbok P, Poskitt KJ, Cochrane DD, Kestle JR. Prevention of postshunting ventricular asymmetry by transeptal placement of ventricular catheters. A randomized study. Pediatr Neurosurg 1994;21:59-64.

60. Suzuki M, Seki H, Yoshimoto T. Unilateral hydrocephalus combined with occlusion of the ipsilateral internal carotid artery. Surg Neurol 1985;24:27-30.

61. Takeshita M, Miyazaki T, Kubo O, Kagawa M, Kitamura K. Case report of paraventricular cerebral cyst of infant (author's trans). No Shinkei Geka 1980;8:73-8.

62. Terrier A, Jourdan C, Remond J, Vighetto A, Peloux A, Naouf H, et al. Unilateral hydrocephalus caused by absence of the choroid plexus. Rev Neurol (Paris) 1992;148:234-6.

63. Thomas WS. Experimental hydrocephalus. J Exp Med 1914;19:106-20.

64. Tien R, Harsh GR 4th, Dillon WP, Wilson CB. Unilateral hydrocephalus caused by an intraventricular venous malformation obstructing the foramen of Monro. Neurosurgery 1990;26:664-6.

65. Tillmann BU, Emons D, Bartmann P, Fahnenstich H. Posthemorrhagic unilateral hydrocephalus. Fenestration of septum pellucidum as an alternative to shunt implantation. J Pediatr 2004;144:126-8.

66. Vajraganti GV, Devi BI, Hegde T, Santosh V, Khanna N, Vasudev MK. Intraventricular tuberculous abscess: A case report. Neurol India 1999;47:327-9.

67. Vaz-Guimarães Filho FA, Ramalho CO, Suriano IC, Zymburg ST, Cavaleiro S. Neuroendoscopic surgery for unilateral hydrocephalus due to inflammatory obstruction of the Monro foramen. Arq Neuropsiquiatr 2011;69:227-31.

68. Venkataratnam NK, Kolluri VR, Swamy KS, Arya BY, Das BS, Reddy GN. Progressive unilateral hydrocephalus in adults. Neurosurgery 1989;24:282-4.

69. Velc H, Laohachemin D, Seidel C, Lasitschka F, Keilbach K, Wiendelbrand AR, et al. S100A8/A9 aggravates post-ischemic heart failure through activation of RAGE-dependent NF-kB signaling. Basic Res Cardiol 2012;107:230.

70. Whyte CA. Images from headache: Unilateral hydrocephalus. Headache 2011;51:148-23.

71. Wilberger JE Jr., Vertosick FT Jr., Vries JK. Unilateral hydrocephalus secondary to congenital atresia of the foramen of Monro. Case report. J Neurosurg 1983;59:899-901.

72. Winchester P, Brill PW, Cooper R, Krauss AN, Peterson HD. Prevalence of “compressed” and asymmetrical lateral ventricles in healthy full-term neonates: Sonographic study. AJR Am J Roentgenol 1986;146:471-5.

73. Zorzan Mj, Biljana SS, Ivanp M. Relocation of ventricular catheter to prevent hydrocephalus due to congenital unilateral hydrocephalus: Nine year follow-up. Surg Neurol Int 2011;2:141.