

Concerns of cerebrospinal fluid leak in aggressive expanded endonasal endoscopic approach for craniopharyngiomas

Abstract

Cerebrospinal fluid leak represents a frequent complication in Craniopharyngioma's Endoscopic Endonasal Approach. A descriptive observational investigation was performed in 50 adult patients operated of Craniopharyngiomas by aggressive Expanded Endonasal Endoscopic Approach (EEEA) in "Hermanos Ameijeiras" Hospital since 2010 to 2019 using nasoseptal flap. The 14% of all patients develop CSF leak and 85,7 % of these cases had a great communication into third ventricle creating a cisternoventricular space. Was identified relation with tumor size, hypothalamic invasion and adhesion strength of tumour. Surgical cavity suffered hydrostatic and hydrodynamic pressure than lead to CSF leak independent of multilayer reparation.

Keywords: Expanded Endonasal Endoscopic Approach (EEEA), Cerebrospinal fluid (CSF) leak

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Introduction

Cerebrospinal fluid (CSF) fistula represents a more frequent complication in Endonasal Endoscopic Approach for Craniopharyngiomas than another skull base tumor.^{1,2} Komotar et al.⁴ report 14% in a metanalysis³ and Jeswani 26,3%.⁴ In centers with great volumes of cases operated by endonasal endoscopic approach using nasoseptal flap refers 10,6% and 14% of incidence.⁵⁻⁹ CSF leak appears in some points of reparations between surgical cavity and nasophenoidal space in few days after surgery. Hydrodynamics physic laws could explain this observation.

Method

A descriptive observational investigation about CSF leak was performed in 50 adult patients operated of Craniopharyngiomas by Expanded Endonasal Endoscopic Approach (EEEA) in Ameijeiras Hospital since 2010 to 2019. Statistics analysis was performed using IBM® SPSS® Statistics Program 23.0. To analyze factors associated

with CSF leak was used Pearson's chi quadrate test with $p < 0,05$ of statistical significance. Viable nasoseptal flap was achieved in all cases and tumor size, hypothalamic invasiveness and adherence was analyzed.

Results

In our series of 50 patients operated by EEEA with aggressive philosophy 14 % developed CSF leak in few days after surgery with a viable nasoseptal flap, similar to an others investigation.¹⁰⁻¹⁴ In 85,7% of cases was identified a great communication with third ventricle space (Table 1) creating a cisternoventricular cavity.

The source of cisternoventricular cavity depend of tumor size, hypothalamic involvement and adhesion strength of tumour. Cisternal and ventricular involvement was more frequent in patient with giant craniopharyngiomas and high hypothalamic invasiveness or adherence (Table 2).

Table 1 Relation of CSF leak and anatomical compartment involvement

Compartment involvement in tumour dissection	CSF leak				P
	No	%	Yes	%	
Cisternal	25	58,1%	1	14,3%	
Cisternal and ventricular	18	41,9%	6	85,7%	
Total	43	100%	7	100%	0,039

Discussion

The creation of cisternoventricular cavity to the end of aggressive EEEA imply a new space that suffers the hydrostatic and hydrodynamic pressure of the CSF.^{15,16}

Hydrostatic pressure: is the force that produce the weight of the liquid in the wall of the cavity. It is proportional with gravity, density and height, and mathematically is:

Hydrostatic pressure= density x gravity x height

Hydrostatic pressure is higher in the skull base than in cranial vault in stand position consequently the risk of CSF leak is greater. In CNS infection the great density of the fluid increases the risk of CSF fistula.

Hydrodynamic pressure: is the force of liquid moving into the cavity, it is defined as velocities vectoral field in relation with fluid particles and a scalar pressure field in different cavity points. The

caudal is the quantity of fluid that pass through a point of the system in a time, example the quantity of CSF that courses into foramen of Monro in a minute.¹⁶

Expanded endonasal endoscopic approach is performed to remove great craniopharyngiomas and frequently third ventricle space is placed through suprasellar cistern and a new compartment is created,

Table 2 Relation of anatomical compartment involvement with size, hypothalamic invasion and tumor's adherence

Variable	Compartment involvement in tumour dissection				P
	Cisternal (N=26)	%	Cisternal and Ventricular (N=24)	%	
Size	Small	10	38,5%	2	8,3%
	Medium- Large	15	57,7%	10	41,7%
	Giant	1	3,8%	12	50%
Hypothalamic Invasion	Grade 0	17	65,3%	4	16,7%
	Grade 1	6	23,1%	10	41,7%
	Grade 2	3	11,5%	10	41,7%
Adherence	Loose	23	88,5%	3	12,5%
	Tight	1	3,8%	7	29,2%
	Fusion	2	7,7%	8	33,3%
	Replacement	0	0%	6	25,0%

Caudal in Monro= Caudal in Silvio= Caudal in Surgical Cavity

Area of Monro x Velocity = Area of Silvio x Velocity = Area of Surgical Cavity x Velocity

As Monro's foramen, aqueduct of silvio and surgical cavity have different dimensions to establish this equality is necessary that the liquid increase or diminish the velocity in different points. Example, increases in Monro point and diminish surgical cavity point.

Bernoulli's theorem relate Energy Conserve Law with hydrodynamic system, and refers that addition of kinetics, gravitational energy and intrinsic pressure is same in different points of the system, mathematically:

$$KE_1 + GPE_1 + P_1 = KE_2 + GPE_2 + P_2$$

If we consider Foramen of Monro as point 1, Surgical Cavity as point 2 and valued that Gravitate Potential Energy in a patient with supine position with 30 grades flexion of the head is same in Monro and Surgical Cavity point them:

$$KE_1 + GPE_1 + P_1 = KE_2 + GPE_2 + P_2$$

$KE_1 + P_1 = KE_2 + P_2$, if is used the equation of Kinetic Energy:

$\frac{1}{2} Density_1 \times Velocity_1^2 + P_1 = \frac{1}{2} Density_2 \times Velocity_2^2 + P_2$, but the density is same in all point of the hydrodynamic system:

$$\frac{1}{2} Density_1 \times Velocity_1^2 + P_1 = \frac{1}{2} Density_2 \times Velocity_2^2 + P_2$$

Finally, there are two variables in balance, velocity and pressure of the liquid. Previously was defined that velocity of the liquid was higher in Monro's point than in Surgical Cavity point, therefore to establish Bernoulli theorem equality the pressure in Surgical Cavity is higher than in Monro point.

cisternoventricular compartment.^{1,2,9,12}

How is the influential of hydrodynamic pressure in this new compartment?

If we apply the Continuity Fluid Laws in Monro's foramen, Silvio aqueduct and Surgical Cavity then:

The increases of liquid pressure into surgical cavity doesn't appear immediately at the end of surgery due to it is leaving during the procedure, it appears 48 hours after surgery and is considered like hydrodynamic effect, and could explain clinical symptoms, and CSF leak late after surgery. We suggest that skull base reparation should be with multilayer components, included fat, fascia and glue it is always associated with nasoseptal flap. If dissection involve only cisternal spaces then lumbar drainage during 72 h could be beneficial, however in giant tumor with high invasiveness is necessary contemplate about the reduction of ventricular pressure before tumor surgery, using different method described.

Conclusion

A cisternoventricular cavity created in aggressive EEEA for great and invasiveness craniopharyngiomas suffers a late hydrodynamic effect that increase local pressure and could favour of CSF leak independently of skull base multilayer reparation.

Acknowledgments

None.

Conflicts of interest

The authors declare no conflicts of interest.

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