

Surgical Treatment of Carotid-cavernous Fistula Performed through the Brazilian Unified Health System

Tratamento cirúrgico de fístula carotídeo-cavernosa realizado por meio do Sistema Único de Saúde

Ilanna Sobral de Luna¹ Airan Lobo da Costa²

¹Departament of Neurology, Faculdade de Medicina, Universidade do Oeste Paulista, Presidente Prudente, São Paulo, Brazil

²Departament of Neurology, Faculdade de Medicina, Universidade do Oeste Paulista, São Paulo, São Paulo, Brazil

Address for correspondence Ilanna Sobral de Luna, Faculdade de Medicina, Departament of Neurology, Universidade do Oeste Paulista, Rua José Bongiovani, 700 - Cidade Universitária, Presidente Prudente, São Paulo, Brazil (e-mail: ilaanna_sobral@hotmail.com).

Arq Bras Neurocir 2021;40(3):e210–e214.

Abstract

Introduction The carotid-cavernous fistula (CCF) is an abnormal communication between the arterial carotid system and the cavernous sinus. In most cases, spontaneous fistulas are due to the rupture of intracavernous carotid artery aneurisms. Traumatic fistulas occur in 0.2% of head injuries, and 75% of all CCFs are caused by automobile accidents or penetrating traumas.

Objective To identify the data regarding the number of annual procedures, hospital expenses, length of hospital stay, and the number of deaths of patients admitted by the Brazilian Unified Health System (SUS, in the Portuguese acronym), in the period between 2007 and 2017, using the surgical code of the surgical treatment for CCF.

Methods The present was an ecological study whose data were obtained by consulting the database provided by the Department of Computer Sciences of the Brazilian Unified Health System (Datusus, in Portuguese).

Results A total of 85 surgical procedures were performed for the treatment of CCFs from January 2007 to October 2017 through the Unified Health System (SUS, in Portuguese), and there was a reduction of 71.42% in this period. The annual incidence of patients undergoing this surgical treatment during the period observed remained low, with 1 case per 13,135,714 in 2007, and 1 case per 51,925,000 in 2017.

Conclusion Despite the low annual incidence of the surgical treatment of CCFs performed by the SUS in Brazil in the period of 2007–2017, based on the data obtained on the average length of stay and expenditures in hospital services, it is necessary that we develop an adequate health planning.

Keywords

- carotid-cavernous fistula
- Brazilian unified health system
- health care

Resumo

Introdução A fístula carotídeo-cavernosa (FCC) é uma comunicação anormal entre o sistema carotídeo e o seio cavernoso. Na maioria dos casos, as fístulas espontâneas ocorrem por ruptura de aneurismas intracavernosos da artéria carótida interna. As fístulas traumáticas ocorrem em cerca de 0,2% dos traumatismos cranioencefálicos,

received
January 5, 2017
accepted
April 24, 2017
published online
June 21, 2018

DOI <https://doi.org/10.1055/s-0038-1657775>.
ISSN 0103-5355.

© 2018. Sociedade Brasileira de Neurocirurgia. All rights reserved. This is an open access article published by Thieme under the terms of the Creative Commons Attribution-NonDerivative-NonCommercial-License, permitting copying and reproduction so long as the original work is given appropriate credit. Contents may not be used for commercial purposes, or adapted, remixed, transformed or built upon. (<https://creativecommons.org/licenses/by-nc-nd/4.0/>)
Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

sendo que 75% de todas as FCCs são causadas por traumas penetrantes ou acidentes automobilísticos.

Objetivo Identificar os dados a respeito do número de procedimentos anuais, os gastos hospitalares, o tempo de internação, e o número de óbitos dos pacientes admitidos pelo Sistema Único de Saúde (SUS), no período de 2007 a 2017, utilizando o código cirúrgico de tratamento cirúrgico de FCC.

Métodos Trata-se de um estudo ecológico, cujos dados foram obtidos por meio de consulta à base de dados disponibilizada pelo Departamento de Informática do SUS (Datasus).

Resultados Foram realizados 85 procedimentos cirúrgicos para tratamento de FCC de janeiro de 2007 a outubro de 2017 por meio do SUS, e ocorreu uma redução de 71,42% neste período. A incidência anual dos pacientes submetidos a este tratamento cirúrgico durante o período observado continuou baixa, apresentando 1 caso para cada 13.135.714 em 2007, e 1 caso para cada 51.925.000 em 2017.

Conclusão Apesar da incidência anual do tratamento cirúrgico de FCC realizado pelo SUS no Brasil no período de 2007 a 2017 ter sido baixa, a partir dos dados obtidos sobre a média de permanência e gastos em serviços hospitalares, é necessário um planejamento adequado em saúde.

Palavras-chave

- fístula carotídeo-cavernosa
- sistema único de saúde
- assistência à saúde

Introduction

Carotid-cavernous fistula (CCF) is an abnormal communication between the carotid system and the cavernous sinus.¹ It is classified according to the etiology as traumatic or spontaneous; according to hemodynamic characteristics, it is classified as high- or low-flow; and depending on the angioarchitecture, it is classified as direct or indirect.² In most cases, spontaneous fistulas occur by rupture of intracavernous aneurysms of the internal carotid artery. Traumatic fistulas occur in ~ 0.2% of cranioencephalic traumas, and 75% of all CCFs are caused by penetrating traumas or automobile accidents.^{3,4}

The signs and symptoms often associated with CCFs vary in installation speed and severity.^{5,6} They are: pulsatile exophthalmos, pulsatile proptosis, Dandy triad, which consists of blowing and venular dilation with chemosis, diplopia, and dysfunctions of cranial nerve pairs III and V; and, in 85% of the cases, dysfunction of cranial nerve pair IV.⁷

For the initial imaging diagnosis when there is suspicion of CCF, computed tomography (CT), magnetic resonance imaging (MRI), angiography by CT, angiography by MRI, or Doppler are requested.^{8,9} However, cerebral angiography is presented as a gold standard for the diagnosis, classification and definitive planning of the endovascular intervention due to the identification of the type, location and size of the connection, as well as the analysis of the arteriovenous environment and the presence of coexistent deviations, mainly ischemic repercussions on the cortex. The differential diagnosis encompasses a vast field of pathologies, including intraorbital lesions such as osteoma, hemangioma, fibrous dysplasia, frontal sinus mucocele and ocular neoplasms.¹⁰

The management of the patient with CCF depends on the risks, and can be performed conservatively, consisting of drug treatment and manual compression therapy, surgical treatment, stereotactic radiosurgery, and transarterial or transve-

nous endovascular repair.¹¹ The surgical approaches are limited because of the associated morbidity of cranial nerve deficits and residual fistulae communications, but are indicated when the proximal arterial access is compromised, preventing endovascular repair, or when failures occur by this method.¹² The approaches may be: ligation of the common carotid artery, surgical segmental isolation of the fistula, and surgical transvenous tamponade. Currently, endovascular therapy is the procedure of choice for CCFs.¹³ Some authors advocate treatment at an early stage, especially with the emergence of intracranial hemorrhage, epistaxis, increased intraocular pressure, reduction of visual acuity or progressive proptosis. Carotid-cavernous fistulas may evolve to complications such as amaurosis, intracerebral hemorrhage, hypertension, cranial nerve palsy, and subarachnoid hemorrhage.^{14,15}

Objective

The goal of the present study is to identify epidemiological data regarding the number of annual procedures, hospital expenses, length of stay and number of deaths of patients admitted by the Brazilian Unified Health System (SUS, in Portuguese) in the period from 2007 to 2017 using the surgical code of surgical treatment for CCF.

Methods

This is an ecological study, whose data were obtained by consulting the database provided by the Department of Computer Sciences of the SUS (Datasus) (<http://www.datasus.gov.br>), which was accessed from October to December 2017. The study sample consisted of all cases of patients undergoing surgical treatment for CCF (code 0403070090) from January 2007 to October 2017. New tables were made based on the data obtained through the Datasus using the

Table 1 Total distribution of the number of surgeries for the treatment of carotid-cavernous fistula from 2007 to 2017 in the Unified Health System

Processed year	Total AHs	%
2007	14	16.47
2008	16	18.82
2009	6	7.06
2010	9	10.59
2011	4	4.71
2012	10	11.76
2013	2	2.35
2014	11	12.94
2015	3	3.53
2016	6	7.06
2017	4	4.71
Total	85	100

Abbreviation: AHs, authorizations for hospitalization.

Note: Source: Ministério da Saúde - Sistema de Informações Hospitalares do Sistema Único de Saúde (SIH/SUS).

Microsoft Word (Microsoft Corporation, Redmond, WA, US) software. Since a public domain bank was used to obtain the data, submission of the project to the Research Ethics Committee was not necessary.

Results

► **Table 1** presents the data referring to the surgical treatment of CCF from January 2007 to October 2017. Out of 85 surgeries, 16 occurred in 2008, the year that had the highest number of cases, representing 18.82% of the total. Comparing the years 2007 and 2017, a decrease of 10 procedures was observed.

In a comparative analysis between the number of procedures in this same period and the Brazilian population, it was possible to notice that, even with the population increase, the annual incidence of patients undergoing this surgical treatment remained low: 1 case for each 13,135,714 in 2007, and 1 case for each 51,925,000 in 2017, as represented in ► **Table 2**.

Regarding the analysis by region, quantitatively, most surgeries occurred in the Southeastern region of Brazil. There were 33 procedures, representing 44.71% of the total. As observed in ► **Table 3**, the Northern region presented the smallest number of surgeries in the period, with 1 procedure, totaling 1.18%.

As evidenced in ► **Table 4**, the mean value of the procedure in 2007 was R\$3,078.32, and R\$2,463.61 in 2017, representing a decrease of 19.9%. In the same period, the value of hospital and professional services suffered a reduction in expenses of 25.43% and 58.77% respectively.

Table 2 Annual Incidence of patients who underwent surgical treatment for carotid-cavernous fistula from 2007 to 2017 in the Unified Health System

Processed year	Total AHs	Brazilian population (millions)	Incidence
2007	14	183.9	1: 13,135,714
2008	16	189.6	1: 11,850,000
2009	6	190.7	1: 31,783,333
2010	9	191.4	1: 21,266,666
2011	4	192.3	1: 48,075,000
2012	10	193.9	1: 19,390,000
2013	2	201.1	1: 19,390,000
2014	11	202.7	1: 18,427,272
2015	3	204.4	1: 68,133,333
2016	6	206.0	1: 34,333,333
2017	4	207.7	1: 51,925,000

Abbreviation: AHs, authorizations for hospitalization.

Note: Source: Ministério da Saúde - Sistema de Informações Hospitalares do Sistema Único de Saúde (SIH/SUS).

Table 3 Distribution by region of the number of surgeries for the treatment of carotid-cavernous fistula from 2007 to 2017 in the Unified Health System

Region	Number	%
Northern	1	1.18
Northeastern	16	18.82
Southern	16	18.82
Southeastern	38	44.71
Midwestern	14	16.47
Total	85	100

Note: Source: Ministério da Saúde - Sistema de Informações Hospitalares do Sistema Único de Saúde (SIH/SUS).

In turn, ► **Table 5** highlights the data regarding the average length of stay in the hospital, as well as the number of deaths. The year with the highest average length of stay was 2014, and there was a variation of 9.8 days between 2007 and 2017. In relation to the number of deaths, they were only reported in 2008, 2012 and 2016.

Discussion

In total, 85 surgical procedures were performed for the treatment of CCF from January 2007 to October 2017 through the SUS, and there was a 71.42% reduction in the number of procedures performed in this period. The endovascular emergency treatment of CCF is reserved for some specific situations, such as in the presence of pseudoaneurysms and increased intracranial pressure. The neuroendovascular

Table 4 Distribution of costs in *reais* (R\$) resulting from surgeries for the treatment of carotid-cavernous fistulas from 2007 to 2017 in the Unified Health System

Processed year	Total value (R\$)	Mean value (R\$)	Value of hospital services (R\$)	Value of professional services (R\$)
2007	43,096.48	3,078.32	23,116.00	6,760.84
2008	47,783.37	2,986.46	37,318.15	10,465.22
2009	21,628.94	3,604.82	17,097.56	4,531.38
2010	21,768.00	2,418.67	15,273.93	6,494.07
2011	12,587.41	3,146.85	8,880.99	3,706.42
2012	38,547.97	3,854.80	27,847.95	10,700.02
2013	6,189.88	3,094.94	4,222.48	1,967.40
2014	33,170.38	3,015.49	22,707.86	10,462.52
2015	7,641.86	2,547.29	4,811.61	2,830.25
2016	28,954.33	4,825.72	22,022.78	6,931.55
2017	9,854.46	2,463.61	5,880.63	3,973.83

Note: Source: Ministério da Saúde - Sistema de Informações Hospitalares do Sistema Único de Saúde (SIH/SUS).

Table 5 Average distribution of days of hospital stay and number of deaths related to surgeries for the treatment of carotid-cavernous fistula from 2007 to 2017 in the Unified Health System

Processed year	Mean stay (days)	Deaths
2007	14.3	–
2008	13.6	1
2009	11.7	–
2010	5.2	–
2011	8.3	–
2012	10.4	1
2013	7.0	–
2014	18.3	–
2015	18.0	–
2016	12.0	1
2017	4.5	–

Note: Source: Ministério da Saúde - Sistema de Informações Hospitalares do Sistema Único de Saúde (SIH/SUS).

treatment is reserved for cases in which the conservative management is ineffective, or before ocular surgical procedures.^{16,17} The endovascular (arterial or venous) approach is the current procedure of choice.

The annual incidence of patients undergoing this surgical treatment during the observed period remained low: 1 case for each 1.3135.714 in 2007, and 1 case for each 51,925,000 in 2017. Although it is not a common pathology in the clinical practice, CCF is a diagnostic hypothesis that should be mandatorily proposed when the clinical picture suggestive of it, since it can develop with important complications, such as intracranial hypertension and cerebral hemorrhage.^{18,19}

In a quantitative analysis according to the Brazilian geographic regions, most surgeries occurred in the Southeastern

region, with a total of 44.71%. The Northern region presented the smallest number of surgeries, with a total of 1.18%. The population density, the type of work activity, the patient's access to health services, and the ability of the health professional to recognize the pathology are some of the factors responsible for the differences observed among the Brazilian regions, which have socioeconomic characteristics that distinguish the reality of health care.²⁰

Comparatively, between 2007 and 2017, there was a reduction in expenditure in SUS services. There was a decrease of 19.9% in the mean value, and a reduction in expenses with hospital services and professionals of 25.43% and 58.77% respectively. The surgical correction of arterio-venous fistulas frequently required large procedures, such as occipital or temporal craniotomy in cases of involvement of the carotid and vertebral arteries. However, with the recent development of catheters and balloons for the treatment of CCFs, the surgeries had their size reduced. Large surgeries are costly for health services, and there is a high probability of fluid and blood loss.²¹ With the expansion of the use of new technologies for CCF treatment, the length of hospitalization was minimized, decreasing the treatment costs when compared with open interventions as well as the resulting complications, which also explains the reduction in the number of days in the average length of stay.

Regarding the number of deaths, which was null in most years, the data evidenced that the additional information arising from the evolution and solvability of neuroimaging techniques increase the accuracy and anticipation of the topographic diagnosis and facilitate the therapeutic access, resulting in greater success in the treatment approach.²²

Conclusion

Despite the low annual incidence of surgical treatment of CCFs performed by the SUS in Brazil in the period from 2007 to 2017, the data obtained on the mean length of stay and

expenses regarding hospital services evidenced the need for a health planning suitable for the Brazilian regions that have the poorest health care indicators regarding this issue, since early diagnosis and neurosurgical intervention in a timely manner promote the reduction of morbidity and mortality.

Conflict of Interests

The authors have none to declare.

References

- Kim J-W, Kim S-J, Kim M-R. Traumatic carotid-cavernous sinus fistula accompanying abducens nerve (VI) palsy in blowout fractures: missed diagnosis of 'white-eyed shunt'. *Int J Oral Maxillofac Surg* 2013;42(04):470-473
- Shinohara Y, Kashima T, Akiyama H, Kishi S. Alteration of choroidal thickness in a case of carotid cavernous fistula: a case report and a review of the literature. *BMC Ophthalmol* 2013;13(01):75
- Carneiro JT Jr, Paschoal EHA, Carreira ASD, Real RPV. Carotid cavernous fistula after surgically assisted rapid maxillary expansion with a bone anchored appliance. *Int J Oral Maxillofac Surg* 2013;42(03):326-328
- Vilela MAP. Carotid-cavernous fistula. *Rev Bras Oftalmol* 2013;72(01):70-75
- Tanweer O, Raz E, Brunswick A, et al. Cavernous carotid aneurysms in the era of flow diversion: a need to revisit treatment paradigms. *AJNR Am J Neuroradiol* 2014;35(12):2334-2340
- Kashiwazaki D, Kuwayama N, Akioka N, Kuroda S. Delayed abducens nerve palsy after transvenous coil embolization for cavernous sinus dural arteriovenous fistulae. *Acta Neurochir (Wien)* 2014;156(01):97-101
- Chi CT, Nguyen D, Duc VT, Chau HH, Son VT. Direct traumatic carotid cavernous fistula: angiographic classification and treatment strategies. Study of 172 cases. *Interv Neuroradiol* 2014;20(04):461-475
- Turfe ZA, Brinjikji W, Murad MH, Lanzino G, Cloft HJ, Kallmes DF. Endovascular coiling versus parent artery occlusion for treatment of cavernous carotid aneurysms: a meta-analysis. *J Neurointerv Surg* 2015;7(04):250-255
- Linfante I, Lin E, Knott E, Katzen B, Dabus G. Endovascular repair of direct carotid-cavernous fistula in Ehlers-Danlos type IV. *J Neurointerv Surg* 2015;7(01):e3
- Barnwell SL, O'Neill OR. Endovascular therapy of carotid cavernous fistulas. *Neurosurg Clin N Am* 1994;5(03):485-495
- Xu X-Q, Liu S, Zu Q-Q, et al. Follow-up of 58 traumatic carotid-cavernous fistulas after endovascular detachable-balloon embolization at a single center. *J Clin Neurol* 2013;9(02):83-90
- Korchi AM, Cuvinciuc V, Caetano J, Becker M, Lovblad KO, Vargas MI. Imaging of the cavernous sinus lesions. *Diagn Interv Imaging* 2014;95(09):849-859
- Chin OY, Ghosh R, Fang CH, Baredes S, Liu JK, Eloy JA. Internal carotid artery injury in endoscopic endonasal surgery: A systematic review. *Laryngoscope* 2016;126(03):582-590
- Rodrigues T, Willinsky R, Agid R, TerBrugge K, Krings T. Management of dural carotid cavernous fistulas: a single-centre experience. *Eur Radiol* 2014;24(12):3051-3058
- Gölitiz P, Struffert T, Lücking H, et al. Parametric color coding of digital subtraction angiography in the evaluation of carotid cavernous fistulas. *Clin Neuroradiol* 2013;23(02):113-120
- Chen C-J, Lee C-C, Ding D, et al. Stereotactic radiosurgery for intracranial dural arteriovenous fistulas: a systematic review. *J Neurosurg* 2015;122(02):353-362
- Ducruet AF, Albuquerque FC, Crowley RW, McDougall CG. The evolution of endovascular treatment of carotid cavernous fistulas: a single-center experience. *World Neurosurg* 2013;80(05):538-548
- Luo C-B, Teng MM-H, Chang F-C, Lin C-J, Guo W-Y, Chang C-Y. Transarterial detachable coil embolization of direct carotid-cavernous fistula: immediate and long-term outcomes. *J Chin Med Assoc* 2013;76(01):31-36
- Lin L-M, Colby GP, Jiang B, Pero G, Boccardi E, Coon AL. Transvenous approach for the treatment of direct carotid cavernous fistula following Pipeline embolization of cavernous carotid aneurysm: a report of two cases and review of the literature. *J Neurointerv Surg* 2015;7(08):e30
- Tomasi E, Facchini LA, Piccini RX, et al. Perfil sócio-demográfico e epidemiológico dos trabalhadores da atenção básica à saúde nas regiões Sul e Nordeste do Brasil. *Cad Saude Publica* 2008;24(01):193-201
- Kim MJ, Shin YS, Ihn YK, et al. Transvenous embolization of cavernous and paracavernous dural arteriovenous fistula through the facial vein: report of 12 cases. *Neurointervention* 2013;8(01):15-22
- Borba R, Sonda I, Dini LI, Calcagnotto FN, Marchetti N, Cobalchini PC. Fístula carótido-cavernosa com epistaxe letal: relato de caso. *Arq Neuropsiquiatr* 2001;59(2-A):276-279