

# CT : 1

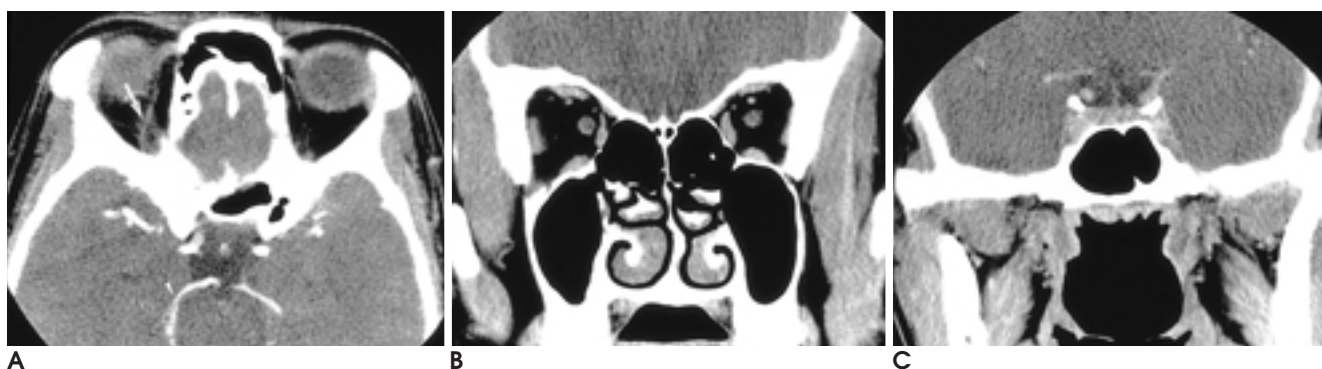
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가 가 .  
: 16 28  
. CT ( 3 mL, 90 mL) 30  
, 가  
CT ,  
, 가 .  
가 , 가  
가 , 가  
: 16 14  
( 88%, 100%). CT  
71%, 100%,  
60%, 83%, 71%, 89%, 가 65%, 98% .  
: CT  
CT , .

(thyroid ophthalmopathy) 가  
(8, 9), 가 (orbital pseudotumor)  
(orbital lymphoma) 가  
(10),  
(11-17).  
(1). CT  
, , , , CT  
, , 가 가 .

(CT) (MRI)  
(2-7). 1995 9 1999 9  
가 11 16 가 5 ,  
(2-4), 17 72 , 45  
CT CT  
CT 1-27  
5  
1996 2 1999 1 28  
CT , 가 10 ,

가 18 16 72 , 38  
 가  
 11 , 가 1 ,  
 가 6 , 4 ,  
 6 , CT  
 가 21 mm  
 (18). 3 가 가  
 CT  
 k - . Landis Koch (19) k -  
 0.6  
 CT CT (HiSpeed  
 Advantage; GE Medical Systems, Milwaukee, Wis)  
 , 90 mL ioversol  
 68% (Optiray 320; Mallinckrodt Medical, Quebec City,  
 Quebec, Canada) (antecubital vein)  
 18 - 3 mL/sec  
 30  
 (inferior orbitomeatal line, Reid's line)  
 3 mm collimation, 3 mm/sec  
 가 5 ,  
 가 11 - 가 2 ,  
 가 2 , 가 7 ( 6 ) (Table  
 1). (11 ), (7 )  
 ), (10 ), (7 )  
 가 7 . 16 5 ,  
 . 10  
 3 CT  
 16 14 , 28  
 (Fig. 1),  
 88%, 100% .  
 71% 100%  
 60% 83% 71%  
 89%, 가 65%  
 98% (Table 2). 16



**Fig. 1.** Helical orbital CT in a control patient

**A.** Axial contrast enhanced CT shows normal superior ophthalmic vein (arrow) that has lower attenuation than ipsilateral posterior cerebral artery (arrowhead) of the same patient.

**B, C.** There is no dilatation of superior ophthalmic vein or bulging of cavernous sinus on coronal CT images.

6 28 2 가 2

1 2 , 1 3 , 2 3

k 1

0.60 0.89

(Table 3).

5

CT 1 (Table 1, Fig. 2).

11

9 11 3

CT (Fig. 3), CT

9 2

(Fig. 3). CT

2

1 CT , 1

CT

CT

10 4 CT

, 2

**Table 1.** CT and Angiographic Findings of 16 CCFs in Consensus by 3 Observers

No.	Helical CT findings					Angiography	
	SOVE	SOVD(A)	SOVD(C)	CSB	EOMT	Type	DSOV
1	+	+	-	+	+	D-CCF	+
2	+	+	+	+	+	D-CCF	+
3	+	+	+	+	+	D-CCF	+
4	+	+	-	+	+	D-CCF	+
5	+	+	-	+	-	D-CCF	+
6	+	-	+	-	-	DAVF	+
7	+	+	+	-	+	DAVF	+
8	-	-	+	+	-	DAVF	-
9	-	-	-	-	-	DAVF	-
10	+	+	-	+	+	DAVF	-
11	+	+	+	-	+	DAVF	+
12	+	+	+	-	+	DAVF	+
13	+	+	-	+	-	DAVF	+
14	+	+	+	+	-	DAVF	-
15	+	+	-	+	-	DAVF	+
16	+	-	-	+	+	DAVF	-

SOVE, early enhancement of superior ophthalmic vein; SOVD(A), dilatation of superior ophthalmic vein on axial image; SOVD(C), dilatation of superior ophthalmic vein on coronal image; CSB, bulging of cavernous sinus; EOMT, thickening of extraocular muscle; DSOV, drainage via superior ophthalmic vein; D-CCF, direct carotid-cavernous fistula; DAVF, cavernous dural A-V fistula.



**Fig. 2.** Helical orbital CT in a 49-year-old woman with direct CCF

**A.** Axial contrast-enhanced CT shows strong enhancement of dilated superior ophthalmic vein (arrow).

**B.** Coronal CT image shows dilatation of the left superior ophthalmic vein (arrow) and asymmetrical thickening of extraocular muscles (arrowheads)

**C.** Bulging of left cavernous sinus (thin arrow) is also demonstrated.

**D.** Angiogram of the left internal carotid artery shows direct shunt flow to cavernous sinus, which drains to superior ophthalmic vein (arrow), petrosal sinuses, and cortical veins.

: CT

64%, MR 92% (2, 4).  
CT CT

CT

(2, 4). Ahmadi (2)

CT

12 86% 14

12 100% , Uchino (4)

MR 12 9 75% ,

CT 50 -

**Table 3.** k-value of Helical CT Signs for Carotid-Cavernous Fistula by 3 Observers

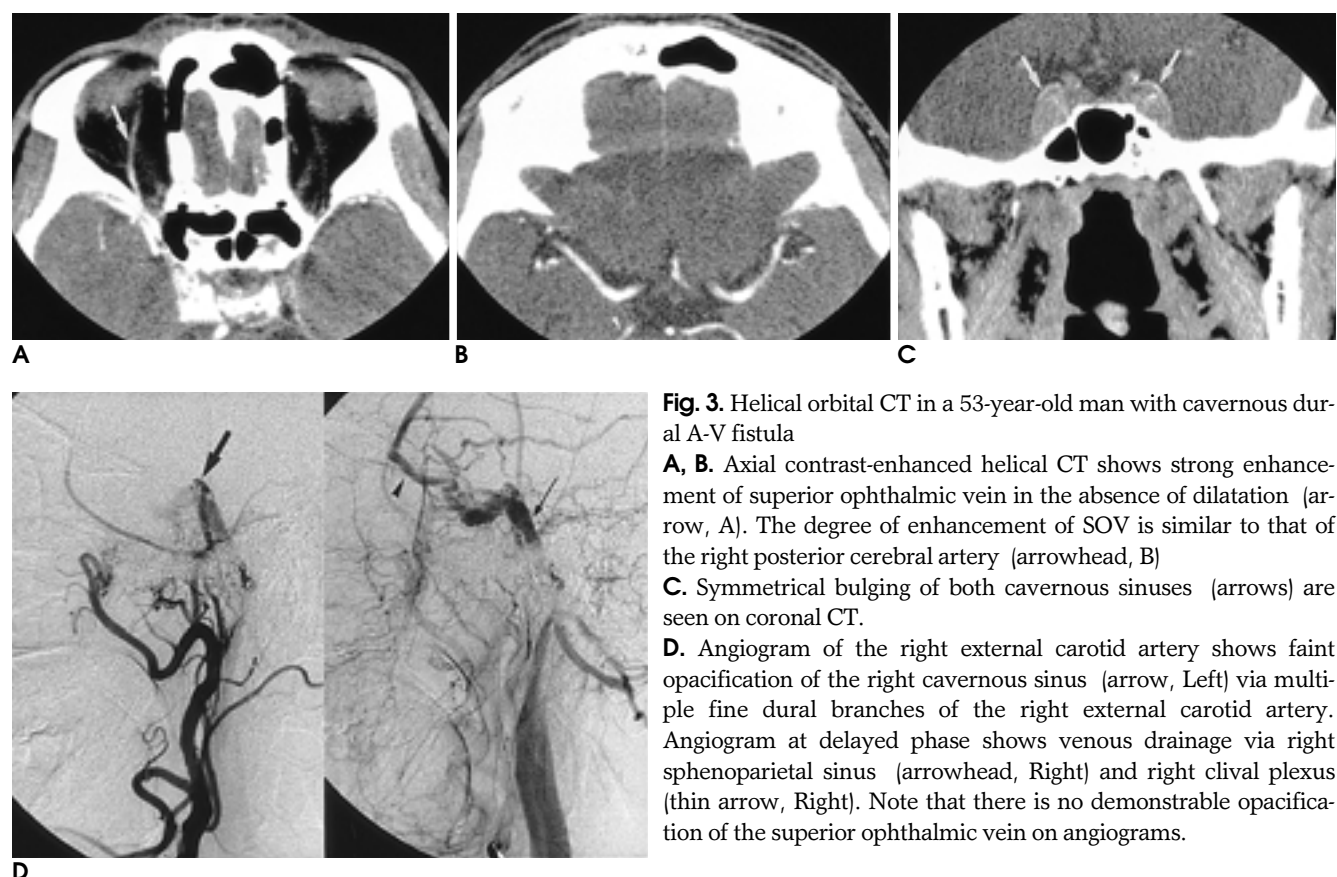
Observer pair	SOVE	SOVD(A)	SOVD(C)	CSB	EOMT
1 vs. 2	1.00	0.71	0.60	0.60	0.71
1 vs. 3	1.00	0.81	0.80	0.73	0.69
2 vs. 3	1.00	0.89	0.61	0.64	0.77

SOVE, early enhancement of superior ophthalmic vein; SOVD(A), dilatation of superior ophthalmic vein on axial image; SOVD(C), dilatation of superior ophthalmic vein on coronal image; CSB, bulging of cavernous sinus; EOMT, thickening of extraocular muscle.

**Table 2.** Sensitivity and Specificity of Helical CT Signs in 16 Patients with Carotid-Cavernous Fistula and 28 Control Patients

Observer	Sensitivity (%)					Specificity (%)				
	SOVE	SOVD (A)	SOVD (C)	CSB	EOMT	SOVE	SOVD (A)	SOVD (C)	CSB	EOMT
1	88	56	56	56	63	100	100	86	82	100
2	88	81	75	88	75	100	100	86	93	96
3	88	75	50	69	56	100	100	79	93	96
Overall	88	71	60	71	65	100	100	83	89	98

SOVE, early enhancement of superior ophthalmic vein; SOVD(A), dilatation of superior ophthalmic vein on axial image; SOVD(C), dilatation of superior ophthalmic vein on coronal image; CSB, bulging of cavernous sinus; EOMT, thickening of extraocular muscle.



**Fig. 3.** Helical orbital CT in a 53-year-old man with cavernous dural A-V fistula

**A, B.** Axial contrast-enhanced helical CT shows strong enhancement of superior ophthalmic vein in the absence of dilatation (arrow, A). The degree of enhancement of SOV is similar to that of the right posterior cerebral artery (arrowhead, B)

**C.** Symmetrical bulging of both cavernous sinuses (arrows) are seen on coronal CT.

**D.** Angiogram of the right external carotid artery shows faint opacification of the right cavernous sinus (arrow, Left) via multiple fine dural branches of the right external carotid artery. Angiogram at delayed phase shows venous drainage via right sphenoparietal sinus (arrowhead, Right) and right clival plexus (thin arrow, Right). Note that there is no demonstrable opacification of the superior ophthalmic vein on angiograms.

가 , 가 .

가 (3, 22, 23).

0.8 - 4.8 mm  
2 - 3.5 mm CT

(20), CT  
(2, 21).

CT

가 , 가

, Ahmani (2)  
14 12 30 40 CT

CT , Uchino (4) 12

CT 9 가  
가 MRI

71%  
k 0.60,

0.61, 0.80

5 2 CT  
3 CT

CT가

가

(11 - 14). Hirai  
19

CT 가 (6)

15

(10), 16 5 가

(9). 가

가 가

가 가 (3D - fast imaging  
with steady - state precession, 3D - FISP)MR  
(6). Hirai (6)

3D - FISP MR

83% 100%

(2 - 4). 86%

(6). 18  
14

(15 - 17).

가 67% 86%

3D - FISP MR

가

가

(8 - 10). 65%

88% 100% Hirai

가 CT

CT CT

- 가 ,
- 가 , CT
- CT
- CT
1. Sander MD, Hoyt WF. Hypoxic ocular sequelae of carotid-cavernous fistulae. *Br J Ophthalmol* 1969;53:82-97
  2. Ahmadi J, Teal JS, Segall HD, et al. Computed tomography of carotid-cavernous fistula. *AJNR Am J Neuroradiol* 1983;4:131-136
  3. Keltner JL, Satterfield D, Dublin AB, Lee BCP. Dural and carotid cavernous sinus fistulas: diagnosis, management, and Complications. *Ophthalmology* 1987;94:1585-1600
  4. Uchino A, Hasuo K, Matsumoto S, Masuda K. MRI of dural carotid-cavernous fistulas: comparisons with postcontrast CT. *Clin Imaging* 1992;16:263-268
  5. Hirabuki N, Miura T, Mitomo M, et al. MR imaging of dural arteriovenous malformations with ocular signs. *Neuroradiology* 1988;30:390-394
  6. Hirai T, Korogi Y, Hamatake S, et al. Three-dimensional FISP imaging in the evaluation of carotid cavernous fistula: comparison with contrast-enhanced CT and spine-echo MR. *AJNR Am J Neuroradiol* 1998;19:253-359
  7. Ikawa F, Uozumi T, Kiya K, et al. Diagnosis of carotid-cavernous fistulas with magnetic resonance angiography-demonstrating the draining veins utilizing 3-D time-of-flight and 3-D phase-contrast techniques. *Neurosurg Rev* 1996;19:7-12
  8. Enzmann D, Marshall WH Jr, Rosenthal AR, Kriss JP. Computed tomography in Graves ophthalmopathy. *Radiology* 1976;118:615-

- 620
9. Nugent RA, Belkin RI, Neigel JM, et al. Graves orbitopathy: Correlation of CT and clinical findings. *Radiology* 1990;177:675-682
  10. Enzmann D, Donnalsen SS, Mashall WH, Kriss JP. Computed tomography in orbital pseudotumor (idiopathic orbital inflammatory). *Radiology* 1976;120:597-601
  11. Glyn AS, Lloyd DM. Pathological veins in the orbit. *Br J Radiol* 1974;47:570-578
  12. Peyster RG, Savino PJ, Hoover ED, Schatz NJ. Differential diagnosis of the enlarged superior ophthalmic vein. *J Comput Assist Tomogr* 1984;8:103-107
  13. Howard GR, Nerad JA, Carter KD. Superior ophthalmic vein enlargement and proptosis caused by middle cranial fossa lipoma. *Am J Ophthalmol* 1990;110:705-706
  14. Khanna RK, Pham CJ, Malik GM, et al. Bilateral superior ophthalmic vein enlargement associated with diffuse cerebral swelling. *J Neurosurg* 1997;86:893-897
  15. Hayman LA, Evans RA, Hinck VC. Rapid high dose (RHD) contrast computed tomography of perisellar vessels. *Radiology* 1979;131:121-123
  16. Kline LB, Acker JD, Post MJD, et al. The cavernous sinus. A computed tomographic study. *AJNR Am J Neuroradiol* 1982;2:299-305
  17. Daniels DL, Czervionke LF, Bonneville JF, et al. MR imaging of the cavernous sinus: Value of spin echo and gradient recalled echo images. *AJNR Am J Neuroradiol* 1988;9:947-952
  18. Hilal SK, Trokel SL. Computerized tomography of the orbit using thin sections. *Semin Roentgenol* 1977;12:137-147
  19. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33:150-174
  20. Brismar J. Orbital phlebography II. Anatomy of superior ophthalmic vein and its tributaries. *Acta Radiol Diagn (Stockh)* 1974;15:481-496
  21. Bacon KT, Duchesneau PM, Weinstein MA. Demonstration of the superior ophthalmic vein by high resolution computed tomography. *Radiology* 1977;124:129-131
  22. Barrow DL, Spector RH, Braun IF, et al. Classification and treatment of spontaneous carotid-cavernous sinus fistulas. *J Neurosurg* 1985;62:248-256
  23. Devrun GM, Vinuela F, Fox AJ, Ahn HS. Indications for treatment and classification of 132 carotid-cavernous fistulas. *Neurosurgery* 1988;22:285-289

## Helical CT Finding of Carotid-Cavernous Fistula: A Sign of Early Enhancing Superior Ophthalmic Vein<sup>1</sup>

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**Purpose:** The purpose of this study was to determine the diagnostic value of a sign of early enhancing superior ophthalmic vein (SOV), as seen on helical CT images in patients with carotid-cavernous fistula (CCF).

**Materials and Methods:** This study involved 16 patients with CCF and 28 control patients. Axial CT images with scanning delays of 30 seconds following bolus injection of contrast material (90 mL, 3 mL/sec) were obtained, and this procedure was followed by coronal CT imaging. To determine the presence or absence of early enhancement or, dilatation of the SOV, bulging of the cavernous sinus, and enlargement of extraocular muscle, CT images were analysed by three observers in a blinded, random manner. Early enhancement of SOV was determined to be present where enhancement of the SOV was similar to or stronger than that of the ipsilateral posterior cerebral artery.

**Results:** A sign of early enhancing SOV was seen in 14 of the 16 patients with CCF but in no control patients (88% sensitivity and 100% specificity). The respective sensitivity and specificity of other CT features were 71% and 100% (dilatation of the SOV, as seen on axial images), 60% and 83% (dilatation of the SOV, as seen on coronal images), 71% and 89% (dilatation of the cavernous sinus), and 65% and 98% (enlargement of extraocular muscle).

**Conclusion:** A sign of early enhancing SOV is a characteristic and specific CT finding of CCF, and is useful for the diagnosis of CCF.

**Index words :** Fistula, carotid-cavernous  
Computed tomography (CT), helical

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