

■ Agenesis of the Right Internal Carotid Artery and Klippel-Feil Syndrome

Case Report

Massimiliano Braga, MD,* Massimo Pederzoli, MD,* Sandro Beretta, MD,†
Massimo Ferrarini, MD,* Paola Canovaro, MD,* Guido Arpaia, MD,‡ and Vittorio Crespi, MD*

Study Design. Case report.

Objective. To describe the case of a Klippel-Feil anomaly associated with carotid agenesis.

Summary of Background Data. Klippel-Feil anomaly is a spinal malformation characterized by fusion of the cervical vertebrae. Four subtypes have been identified for this congenital disorder with different severity of vertebral fusion and different extra-axial anomalies. Most cases are sporadic, although autosomal dominant and autosomal recessive cases are recognized. It can cause neurologic disorders and is associated to vascular abnormalities. However, agenesis of internal carotid and Klippel-Feil syndrome is an unusual association.

Methods. A 49-year-old woman came to our attention for recurrent transitory ischemic attacks presenting with weakness of left limbs associated with sensory abnormalities. Neurologic examination revealed mild left limb weakness and tactile hypoesthesia.

Results. Brain magnetic resonance (MR) and MR angiography demonstrated absence of the right internal carotid and the middle right cerebral artery was filled from the basilar artery. Fusion of vertebral bodies was documented at MR and confirmed at spinal CT scan. The day after the admission the neurologic examination became normal. Ticlopidine was then started.

Conclusion. Literature of vascular abnormalities in association with Klippel-Feil syndrome takes the form of anecdotal reports. Aortic coarctation, vertebral artery dissection, aneurysms, persistent trigeminal artery, and abnormal origin of internal carotid are described. An unusual association of carotid internal agenesis and Klippel-Feil syndrome is reported with a literature review.

Key words: Klippel-Feil, carotid agenesis, magnetic resonance imaging. **Spine 2009;34:E740–E742**

syndrome is at least 1 in 40,000 live births.⁵ Affected patients manifest a wide variety of anomalies affecting the spine, the ear, the eye, the nervous system, the kidney, and other organs.

Four subtypes have been identified for this congenital disorder with different severity of vertebral fusion and different extra-axial anomalies.^{6–8}

Vascular disruption involving the subclavian artery has been put forth as a possible cause of Klippel-Feil syndrome.⁹ A teratogenic basis has been postulated for some human cases and has received experimental support. Recently,¹⁰ defects of postotic neural crest differentiation was suggested. Skeleton identified as neural crest derived is specifically affected in Klippel-Feil syndrome. Cervical hypomobility is explained with ectopic ossification of prevertebral ligaments of pharyngeal muscles and connective tissues around the somitic mesodermal neck vertebrae.

Prognosis and complications depend on the severity and extent of anomalies. Individuals with few or mild extra-axial anomalies may not have symptoms during childhood and may reach early adulthood before the onset of more severe neurologic complications. Cervical instability, occipitocervical anomalies, degeneration of discs or joints, and scoliosis may develop over time and lead to neurologic complications. Renal or cardiovascular anomalies may require more intensive treatment. Hypromobility of the cervical spine can also be asymptomatic, even for periods of several decades, or associated with traumatic spinal cord injury.¹¹ Cervical vertebral anomalies may also be associated with vertebral artery dissection.¹² Mental retardation occurs in approximately 10% of patients.

■ Case Reports

A 49-year-old previously healthy woman came to our attention because of several episodes of transient paresthesias and left limb weakness. Medical history was positive for medically untreated hypertension. General examination demonstrated obesity and short neck. Intelligence was normal. Neurologic examination revealed mild left limb weakness and tactile hypoesthesia. Routine blood examination and brain CT scan were unremarkable. Because of possible cerebrovascular event, the patient was admitted to Stroke Unit, and a carotid artery ultrasonography was performed. At the right side, the anatomy and the course of blood vessels were not clearly identifiable and a small tortuous vessel was detectable.

Klippel-Feil syndrome is mainly characterized by a defect in the formation or segmentation of cervical vertebrae. The clinical triad consists of short neck, low posterior hairline, limited head motion.¹ Most cases are sporadic, although autosomal dominant^{2,3} and autosomal recessive⁴ cases are recognized. The incidence of Klippel-Feil

From the *U.O. di Neurologia, †Servizio di Risonanza Magnetica, and ‡U.O. Medicina II, Ospedale Civile di Vimercate, Vimercate, Milan, Italy.

Acknowledgment date: November 6, 2008. Acceptance date: March 9, 2009.

The manuscript submitted does not contain information about medical device(s)/drug(s).

No funds were received in support of this work. No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

Address correspondence and reprint requests to Massimiliano Braga, V. Cesare Battisti 23, 20059 Vimercate, Milan, Italy; E-Mail: milanobraga@hotmail.com

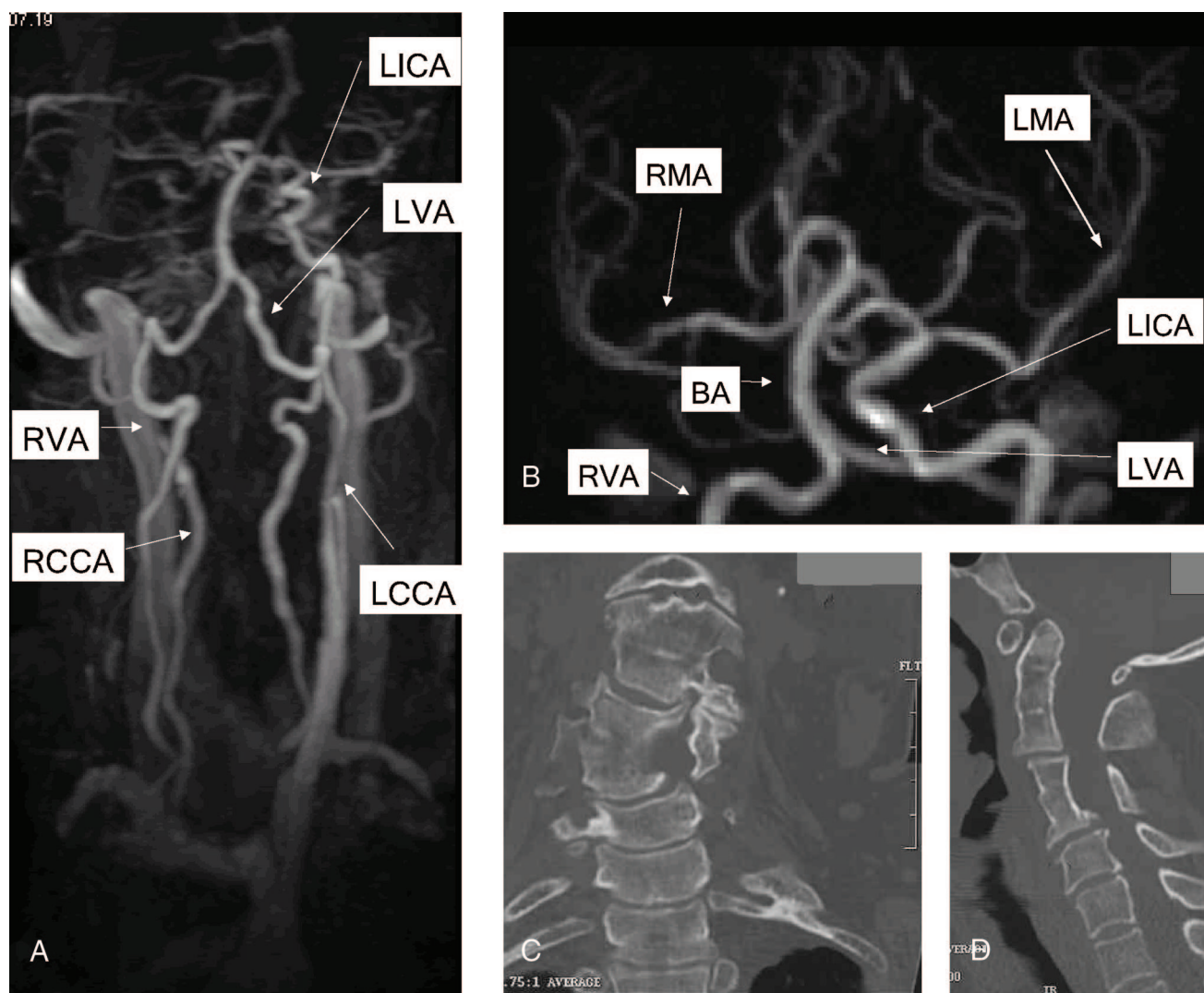


Figure 1. **A**, MR angiography: agensis of right internal carotid. **B**, MR angiography: the right middle cerebral artery was filled from the basilar trunk. **C** and **D**, CT cervical scan: C2–C3 and C4–C5 fusion and dismorphism of vertebral bodies.

Internal right carotid artery was not detectable. Brain MR and Contrast-enhanced MR angiography of extracranial and intracranial vessels were then performed (Figure 1A, B). Brain MR was negative for parenchymal lesion, in particular did not evidenced ischemic alterations. Fusion of vertebral C3 and C4 bodies was suspected on sagittal sections. Right internal carotid was not detectable at MR intracranial angiography; collateral circulation of the middle cerebral artery was via posterior communicating artery. Extracranial MRI angiography showed a small vessel that from the aortic arch continues to the external carotid artery at the right side (Figure 1A). Cervical vertebral fusion suggested a Klippel-Feil syndrome, and the patient underwent to cervical CT scan (fusion of C2–C3 and C4–C5 vertebral bodies, Figure 1C, D), rx scan of the entire spine (cervical C7 rib), abdomen CT scan (agenesis of the left kidney), and echocardiogram (left ventricle hypokinesia with mild reduction of ejection fraction).

At day 1 from the admission the patient became completely asymptomatic and the neurologic examination

appeared normal. A diagnosis of transient ischemic attack was made and ticlopidine was started.

■ Discussion

Vascular abnormalities (persistence of trigeminal artery,¹³ aortic coarctation,¹⁴ thoracic bifurcation of the common carotid artery,¹⁵ subclavian steal¹⁶) are anecdotically described in Klippel-Feil syndrome. A pathogenetic role of abnormal arterial supply was postulated by some authors.^{9,16} Others consider aberrant differentiation of postotic neural crest cells as a crucial factor of vertebral abnormalities.¹⁰ Agensis of internal carotid artery is a rare congenital disorder often associated to other malformations.¹⁷ This is in our best knowledge the first report of agensis of ICA and Klippel-Feil syndrome. In this case collateral circulation of the middle cerebral artery was via the posterior communicating artery, as in other reports (Figure 6, Type A, of ref. 17), and the external carotid artery is directly connected to the aorta. Agensis and aplasia of internal carotid artery may be

entirely harmless or induce cerebrovascular disorders as in this case.

■ Key Points

- Some vascular abnormalities (aortic coarctation, vertebral artery dissection, aneurysms, persistent trigeminal artery) are reported in Klippel-Feil syndrome.
- Internal carotid agenesis is a rare malformation.
- Unusual association of Klippel-Feil and carotid agenesis is described in this report.

References

1. Tracy MR, Dormans JP, Kusumi K. Klippel-Feil syndrome: clinical features and current understanding of etiology. *Clin Orthop Relat Res* 2004;424:183–90.
2. Bauman GI. Absence of the cervical spine: Klippel-Feil syndrome. *JAMA* 1932;98:129–32.
3. Clemmesen V. Congenital cervical synostosis (Klippel-Feil's syndrome): four cases. *Acta Radiol* 1936;17:480–90.
4. Da-Silva EO. Autosomal recessive Klippel-Feil syndrome. *J Med Genet* 1982;19:130–134.
5. Scott CL Jr. Pectoral girdle, spine, ribs, and pelvic girdle. In: Stevenson RE, Hall JG, Goodman RM, eds. *Human Malformations and Related Anomalies*. Vol 2. New York, NY: Oxford University Press; 1994. 670–71.
6. Gunderson CH, Greenspan RH, Glaser GH, Lubs HA. The Klippel-Feil syndrome: genetic and clinical reevaluation of cervical fusion. *Medicine* 1967;46:491–512.
7. Raas-Rothschild A, Goodman RM, Grunbaum M, et al. Klippel-Feil anomaly with sacral agenesis: an additional subtype, type IV. *J Craniofac Genet Dev Biol* 1988;8:297–301.
8. Mahirogullari M, Ozkan H, Yildirim N, et al. Klippel-Feil syndrome and associated congenital abnormalities: evaluation of 23 cases. *Acta Orthop Traumatol Turc* 2006;40:234–9.
9. Bouwes Bavinck JN, Weaver DD. Subclavian artery supply disruption sequence: hypothesis of a vascular etiology for Poland, Klippel-Feil, and Moebius anomalies. *Am J Med Genet* 1986;23:903–18.
10. Matsuoka T, Ahlberg PE, Kessaris N, et al. Neural crest origins of the neck and shoulder. *Nature* 2005;436:347–55.
11. Vaidyanathan S, Hughes PL, Soni BM, et al. Klippel-Feil syndrome. The risk of cervical spinal cord injury: a case report. *BMC Fam Pract* 2002;3:6.
12. Hasan I, Wapnick S, Kutscher ML, et al. Vertebral arterial dissection associated with Klippel-Feil syndrome in a child. *Childs Nerv Syst* 2002;18:67–70.
13. Paksoy Y, Seker M, Kalkan E. Klippel-Feil syndrome associated with persistent trigeminal artery. *Spine* 2004;29:E193–6.
14. Franzen D, Schulte B, Beyer D, et al. Klippel-Feil syndrome associated with aortic coarctation. *Cardiovasc Pathol* 2003;12:115–7.
15. Rielly JP. Intrathoracic carotid bifurcation in Klippel-Feil syndrome. *J Vasc Surg* 2008;47:1071–3.
16. Brill CB, Peyster RG, Keller MS, et al. Isolation of the right subclavian artery with subclavian steal in a child with Klippel-Feil anomaly: an example of the subclavian artery supply disruption sequence. *Am J Med Genet* 1987;26:933–40.
17. Given CA II, Huang-Hellinger F, Baker MD, et al. Congenital absence of the internal carotid artery: case reports and review of the collateral circulation. *Am J Neuroradiol* 2001;22:1953–9.