A New Minimally Invasive Technique for Cauterizing the Maxillary Artery and Its Application in the Treatment of Cluster Headache

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Purpose: To describe a new, relatively atraumatic method of cauterizing the maxillary artery and its effectiveness in treating cluster headache.

Materials and Methods: Five patients with cluster headache were treated with arterial ligation of certain terminal branches of the external carotid artery. A new, atraumatic method of cauterizing the maxillary artery is described.

Results: The success rate and postoperative morbidity are presented. In four out of five patients the cluster attacks ceased immediately following surgery.

Conclusion: A new intraoral technique for maxillary artery cauterization and the effectiveness of cauterization of the terminal branches of the external carotid artery in the treatment of cluster headache are described. Although the sample is small, the results are encouraging, and may offer permanent relief of cluster headache pain.

J Oral Maxillofac Surg 71:677-681, 2013

Cluster headache (CH), formerly called *cluster migraine*, is the most frequent of the trigeminal autonomic cephalalgias. It is one of the most painful conditions known and as such has been referred to as "suicide headache." CH occurs with a lifetime prevalence of 124 per 100,000 and is 4.3 times more common in men than in women.[1] Diagnostic criteria for CH have been established by the International Headache Society, which recognizes the episodic and chronic forms.[2] Episodic CH occurs 6 times more commonly than chronic CH.[1] The pain in CH is strictly unilateral and most often is localized to the region supplied by the maxillary artery (MA), namely the periorbital, retro-orbital, and orofacial areas, and may be of a toothache-like nature.[3] The pain is accompanied by at least 1 of the following autonomic symptoms, all of which are ipsilateral to the pain: conjunctival injection, lacrimation, nasal congestion, rhinorrhea, forehead and facial sweating, miosis, ptosis, and eyelid edema.[2] These features of CH are thought to be related to the parasympathetic and sympathetic innervation of the sphenopalatine ganglion (SPG).[4] The third section of the MA courses through the infratemporal fossa (Fig 1),[5] and the anatomic location of the SPG is in the region supplied by this portion of the MA. Surgical cauterization of the terminal branches of the external carotid artery has proved effective in patients with migraine who respond to rescue treatment with triptans.[6] The most effective rescue treatment for CH is with triptans. Although some patients can adequately control CH using prophylactic medication, many episodes are refractory and, in some cases, medication cannot be used because of undesirable side effects.[7] In those patients who respond favorably to vasoconstrictor rescue medications such as the ergots or triptans, it appeared feasible that permanent closure by cauterization of the involved arteries could be a solution to the problem. This form of treatment has been used successfully for chronic migraine in which vascular involvement has been positively diagnosed.[6] The tenderness to palpation of the retromaxillary tissues on the painful side during a cluster period and particularly the exquisite tenderness during an attack suggest the presence of inflammation, possibly sterile neurogenic inflammation, in the vicinity of the MA. It is postulated that the autonomic symptoms that occur

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0278-2391/12/01659-X$36.00/0

http://dx.doi.org/10.1016/j.joms.2012.12.001

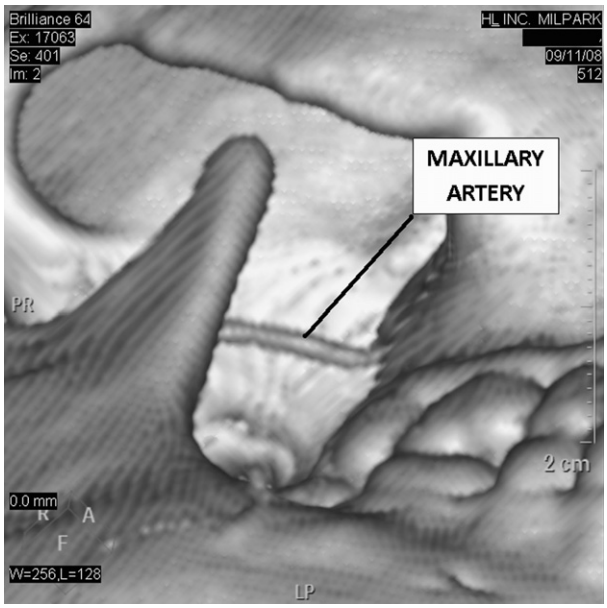

FIGURE 1. Computed tomographic angiogram showing the maxillary artery coursing through the pterygopalatine fossa.

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during CH may be the result of the effect of neurogenic inflammation on the autonomic elements in the SPG. The decrease in pain during an attack from compression of the MA strongly suggests that it is involved in the pain of CH.

There are several other indications for cauterizing the MA. During maxillary (Le Fort I, II, or III) or midfacial osteotomy, profuse bleeding is possible and complications such as postoperative hemorrhage, false aneurysm, and arteriovenous fistula have been reported.[8-10] In cases of intractable posterior epistaxis, if posterior nasal packing fails, ligation, cauterization, or embolization of the MA may be necessary.[11-13] The atraumatic method of cauterizing the MA through an intraoral approach described here also may prove useful for these applications.

Materials and Methods

Ethical approval was obtained from the research ethics committee of the South African Medical Association.

Under sedation and with local anesthesia, the superficial temporal artery main trunk, its frontal branch, and the occipital arteries were cauterized bilaterally as described elsewhere.[6] Although CH is unilateral, these arteries are cauterized bilaterally because of the extensive anastomoses between the left and right sides.[14] The MA is cauterized only on the painful side. The procedure is carried out in a day facility.

MAXILLARY ARTERY

The course of the MA in the infratemporal fossa is variable, but it can be determined accurately with a 3-dimensional computed tomographic angiogram (Fig 1). A Doppler flowmeter (Parks Doppler Model 811B with pencil probe (Parks Medical Electronics, Aloha, Oregon) (Fig 2) is used during surgery to confirm its exact location (Fig 3). A local anesthetic solution is injected into the retromaxillary tissues, above and below the Doppler probe, with the needle parallel to the Doppler probe. The needle is advanced until it strikes the base of the skull to ensure full-depth anesthesia.

Pinholes are then made in the mucosa above and below the Doppler probe with a 15-gauge needle. Each pinhole is then widened using a blunt tapering metal probe (Fig 2), which is advanced until the basal surface of the greater wing of the sphenoid bone at the cranial base is encountered. The direction in which this probe is advanced must be parallel to the direction of the Doppler probe when the artery is heard (Fig 3). This ensures that there is a preformed channel on either side of the MA, into which the tips of the bipolar cautery probe (Erbe 25-cm 0.4-mm Bayonet Non-Stick (ERBE USA, Inc., Marietta, Georgia) (Fig 2) are advanced, one on either side of the artery (Fig 4). The cautery probe is then advanced, also at the same

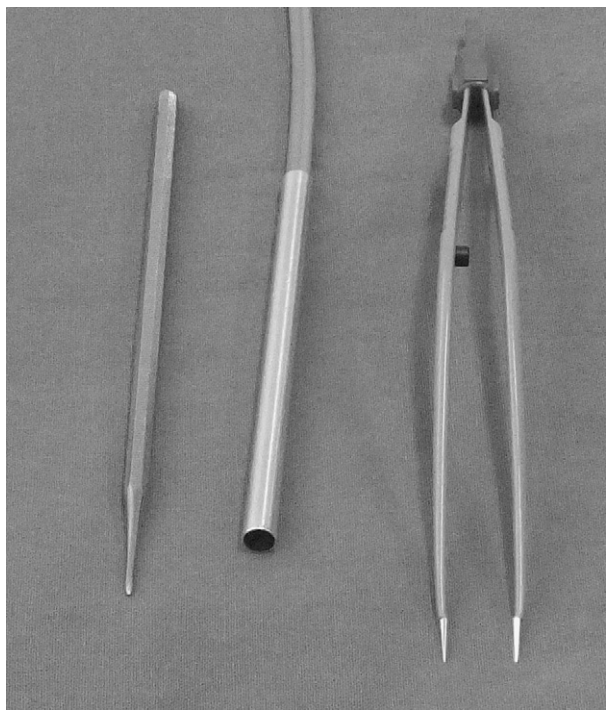

FIGURE 2. Blunt tapering probe (Parks Doppler pencil probe; Erbe 25-cm 0.4-mm Bayonet Non-Stick).

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FIGURE 3. Doppler probe locating the maxillary artery.

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angle as the Doppler probe, into the enlarged pinholes, stopping every 2 to 3 mm to clamp the ends together and listen with the Doppler until the MA is silenced by the clamped cautery probe. A coagulation pulse of 40 W is activated for approximately 4 seconds,

FIGURE 4. Bipolar cautery probe in situ.

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after which the probe is removed, and the Doppler is reapplied to the mucosa. The procedure is completed when the MA blood flow can no longer be heard with the Doppler probe. The procedure is generally atraumatic and, because it is carried out through pinholes, no sutures are necessary. Blunt instruments are used to prevent accidental puncture of the MA.

Postoperative antibiotic cover for 5 days with amoxicillin 500 mg every 8 hours and metronidazole 400 mg every 8 hours is recommended.

PATIENTS

Five patients, 4 with episodic CH and 1 with chronic CH, underwent the procedure from June 2010 to July 2011. All selected patients had proved refractory to preventive treatments, but they were responsive to vasoconstrictors if taken before the pain became severe. Involvement of the terminal branches of the external carotid artery was confirmed clinically in all 5 patients. On clinical examination interictally, the cluster "shadow" decreased with digital compression of the superficial temporal, frontal, and occipital arteries bilaterally. MA involvement in the pain was confirmed interictally by finger pressure applied to the retromaxillary tissues. The affected side is always more tender than the contralateral side in patients with CH. In 2 patients who were examined during a cluster attack, finger pressure to the retromaxillary tissues not only was exceedingly painful on the affected side compared with the contralateral side, but also decreased the severity of the cluster pain temporarily, presumably because of compression of the MA.

Patient 1 was a 43-year-old man with refractory right-side CH. He had been diagnosed by a neurologist elsewhere 10 years previously with chronic CH and had been treated with various medications, including topiramate and prednisone, without relief. Oxygen therapy had helped to abort some attacks for some years, but was no longer effective. The attacks could be aborted at times by sumatriptan injection if it was administered early in the attack before the pain became severe. The attacks were irregular, with a frequency of 3 to 4 a day and a maximum duration of 1 hour. The attacks were accompanied by a burning sensation of the right nares and "irritation" of the maxillary gingivae on the right side. The surgery was carried out on June 24, 2010. The clusters stopped immediately after surgery, and by September 1, 2012, there had been no further attacks.

Patient 2 was a 63-year-old man who had been diagnosed by a neurologist elsewhere in 2005 with right-side episodic CH. He had reported a temporary improvement of 1 week with topiramate and prednisone and responded well to sumatriptan injections if administered before the pain became severe. The

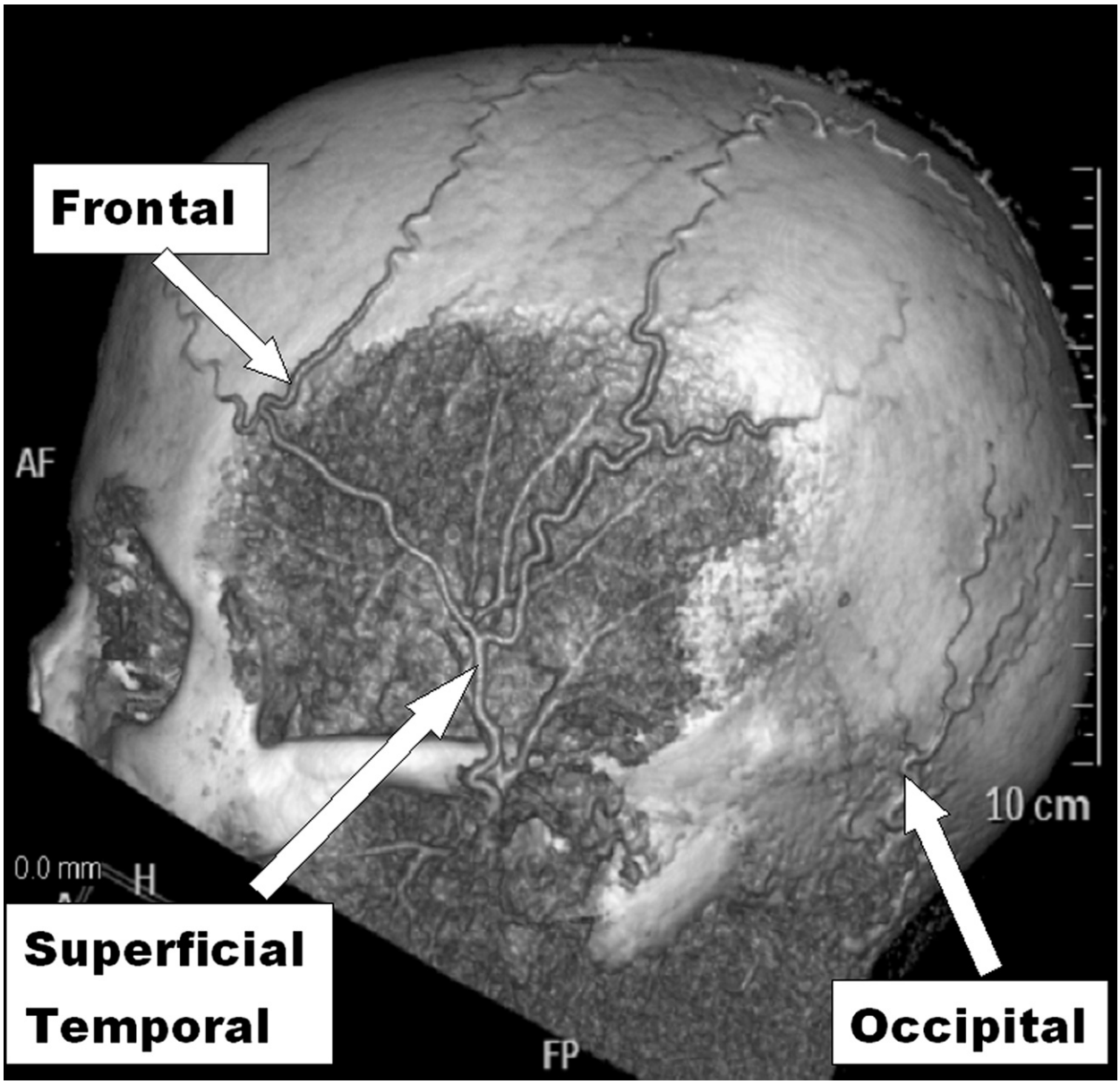

FIGURE 5. Computed tomographic angiogram showing the occipital, superficial temporal, and frontal arteries.

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surgery was carried out on August 19, 2010. The clusters stopped immediately, and on follow-up on September 1, 2012, he reported that he had to date had no further attacks.

Patient 3 was a 59-year-old man who had left-side episodic CHs for 8 years; his clusters occurred regularly every year in April. There had been no response to topiramate and prednisone, but the attacks were controlled with sumatriptan injections if used before the pain became severe. All his attacks occurred at night, although, more frequently than not, he was awoken by the attack and the drug was not helpful. The surgery was carried out on May 4, 2011. The clusters stopped immediately after surgery, and on August 23, 2012, he reported that he had had no further attacks.

Patient 4 was a 55-year-old man with right-side episodic CH that began 16 years previously. He was into the second week of his cluster, which usually lasted 4 to 6 weeks. There were 2 attacks per day. He had used verapamil, prednisone, oxygen, and sumatriptan injections. Only the sumatriptan provided relief if he used it before the pain became severe, but not when he was woken by the pain. The surgery was carried out on June 20, 2011. The clusters stopped immediately after surgery, and by September 1, 2012, there had been no further attacks.

Patient 5 was a 48-year-old woman with left-side episodic CH of 8 years' standing. She had just started her present cluster. Her cluster had in the past lasted 3 to 8 weeks. She was experiencing 4 to 5 attacks every 24 hours at the time of surgery. She had previously used prednisone, topiramate, and oxygen, without any benefit. Most attacks responded well to sumatriptan injections. The surgery was carried out on July 18, 2011, but the CH attacks continued unchanged.

All patients underwent preoperative computed tomographic angiography to determine the precise subcutaneous positions of the superficial temporal, frontal, and occipital arteries (Fig 5), the course of the MA in the infratemporal fossa (Fig 1), and the possible presence of anatomic variations.

POSTOPERATIVE MORBIDITY

There may be localized swelling and limitation of movement for up to 2 weeks, for which nonsteroidal anti-inflammatory drugs are prescribed. In 1 patient the pain and swelling were more severe, with limitation of mouth opening for 4 weeks. This complication rate compares with 14% for embolization and 26% with transantral ligation.[13] The statistics and postoperative morbidity for this procedure may prove to be inaccurate because they are based on a small number of cases.

Results

Four of the 5 patients have reported no further cluster attacks since the surgery. Patient 4 had a cluster attack start during the procedure and reported immediate cessation of his pain the moment the MA was cauterized. The failure rate of 20% may be ascribed to the fact that it is a blind procedure and to the difficulty of access in some patients. This compares with a 20% failure rate with embolization and a 12% rate with transantral ligation.[13]

Discussion

In the treatment of CH, the possibility must always be borne in mind that the cluster stopped spontaneously, not because of the intervention, but because of the natural progression of the disease. This could not have been the case with patient 1 who had chronic CH. Also, the fact that the attacks stopped immediately after the surgery in 4 of 5 cases makes it statistically highly unlikely that all 4 happened to obtain spontaneous relief directly after surgery. What is also significant is that patient 4 had an attack that started during the surgery. Without prompting and without being aware of what stage the surgery had reached, he reported that the pain ceased at the moment the MA was clamped and cauterized. The autonomic features of CH are thought to be related to parasympathetic activity in the SPG. Lacrimation, nasal congestion, and rhinorrhea are manifestations of parasympathetic activation. Sympathetic fibers transit the SPG, and some cluster attacks manifest a partial Horner syndrome, suggesting sympathetic paresis.[4] The exquisite tenderness to palpation of the retromaxillary tissues during a cluster attack indicates the presence of inflammation, possibly sterile neurogenic inflammation in the vicinity of the MA. It is postulated that the autonomic symptoms that occur during CH, namely conjunctival injection, lacrimation, nasal congestion, miosis, ptosis, and eyelid edema, may be the result of the effect of neurogenic inflammation on the autonomic elements in the SPG.

In conclusion, a new atraumatic technique for cauterizing the MA has been described. Four of 5 patients with CH were successfully treated using this technique. Although the sample was small, this appears to be a promising new treatment for CH.

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