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What is This?
Vascular Anastomoses in the Region of the Mandibular Symphysis

DAVID R. REDDEN, JACK G. BISHOP, JAMES L. MATTHEWS, and HOMER L. DORMAN

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Unilateral and bilateral mandibular resection and the treatment of compound fractures of the mandible indicate that the mandibular artery may be ligated without compromising the vitality of the tissues distal to the ligature.1-3 The exact pattern of the circulatory complex in this tissue are is not sufficiently understood to explain these findings. Hawkins3 has suggested that the vascular anastomosis across the mid-line of the mandible is limited but that the lips and the neighboring soft tissue contain many anastomotic branches of the mental and facial arteries. Ryder4 found that the canals and foramina of the mandible transmit anastomosing vessels which connect the inferior dental and sublingual arteries. MacGregor5 cannulated both mandibular arteries of the fractured jaw of a post mortem subject and reported that an anastomosis existed across the symphysis. Recently Bishop, Matthews, Dorman, and Moore6 injected thorium dioxide into the mandibular artery of dogs. Radiographic analysis revealed a minimum amount of crossover between the left and right side of the mandible with a minimum perfusion pressure.

A study of the blood pressure in the cannulated mandibular arteries of dogs was therefore undertaken in an attempt to resolve these viewpoints.

EXPERIMENTAL METHODS

Mongrel dogs of varying age and sex were anesthetized with sodium pentobarbital, 33 mg/kg body weight. The blood of each animal was rendered non-coagulable by intravenous injection of heparin, 5 mg/kg, 30 minutes before each experimental series was undertaken. Blood pressure was recorded by use of a calibrated strain gauge,* amplifier,† and ink-writing oscillograph.

The right mandibular artery was exposed by an inframandibular incision lateral to the mid-line. The right diagastric muscle was dissected free of deep fascia and pulled laterally by a ligature around the belly of the muscle. Dissection was continued until the internal pterygoid muscle and its insertion were separated from the mandible. The exposed mandibular artery was tied off near the internal maxillary artery, and a polyethylene cannula which had a bore size that approximated the lumen size of the artery was inserted distally.

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* Statham Instruments, Los Angeles, Calif.
† Brush Electronics Co., Cleveland, Ohio.
The right femoral artery was ligated distal to the inguinal ligament and cannulated. The mandibular cannula was connected to the junction of a 10-ml syringe (Fig. 1) and to the pressure transducer. Back-pressure in the mandibular artery was continuously monitored, while removal of the femoral cannula clamp allowed intermittent measurement of the systemic blood pressure. The syringe was used to inject thorium dioxide, and the cannula arrangement permitted the perfusion pressure to be observed.

Appropriate incisions were used to expose the left and right common carotid arteries, and heavy cord ligatures were used to occlude these vessels for short periods. Mechanical blocks of the mandibular symphysis were accomplished by means of a hemostat clamped so as to include the skin and the lingual aspect of the gingiva. Radiographs were made, using a dental X-ray unit on fine-grain no-filter film.

RESULTS

Measurements of femoral blood pressure were made as soon as the cannula system was in place and the values obtained averaged 175 mm. of mercury. Following these determinations the femoral cannula was clamped, and the pressure in the cannulated distal segment of the right mandibular artery was recorded. Back-pressures in the right mandibular artery (Table 1) ranged between 100 and 135 mm. of mercury with a mean of 115 mm. If the femoral blood pressure can be taken as an index to the pressure in the proximal segment of the mandibular artery, these values represented a back-pressure which was only 30 per cent less than the normal forward-perfusing pressure of the blood column. Obviously, then, arterial blood entered the distal branches of the mandibular artery from sources other than the proximal branch from the internal maxillary artery.

Occlusion of the left common carotid artery while measuring back-pressure in

![Cannula connections in the perfused animal](image-url)
the right mandibular artery resulted in a decrease in back-pressure from an average of 115 to 90 mm/Hg, while occlusion of the right common carotid artery decreased the back-pressure to 103 mm/Hg (average). Occlusion of the left and right common carotid arteries decreased the back-pressure in the right mandibular artery to an average of 68 mm/Hg (Fig. 2). A mechanical clamp across the mandibular symphysis between the lingual aspect of the gingiva and the skin surface reduced the back-pressure to 78 mm/Hg. Occlusion of the left and right common carotid arteries and a mechanical block on the mandibular symphysis applied simultaneously (Fig. 3). Insertion of the finger into the mouth and application of substantial pressure to the tissues overlying the left mandibular canal reduced the back-pressure in the right mandibular artery to 53 mm/Hg (Fig. 4). The back-pressure decreases resulting from these manipulations are summarized in Figure 5.

TABLE 1

<table>
<thead>
<tr>
<th>BACK-PRESSURE IN RIGHT MANDIBULAR ARTERY WITH</th>
<th>ANIMAL NO.</th>
<th>FEMORAL PRESSURE</th>
<th>BACK-PRESSURE IN MANDIBULAR ARTERY</th>
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|                                             | Mean       | 175              | 117.2                               |

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<tr>
<th>BACK-PRESSURE IN RIGHT MANDIBULAR ARTERY WITH</th>
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<th>Left Carotid Block</th>
<th>Left and Right Carotid Block</th>
<th>Symphysis Block</th>
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Fig. 2.—Record of effect of blood supply manipulation on back-pressure
Fig. 3.—Record of back-pressure drop due to mechanical block of the mandibular symphysis and left and right carotid arteries.

Fig. 4.—Back-pressure drop in the right mandibular artery with pressure block on the left mandibular artery.

Fig. 5.—Average back-pressure drop with common carotid artery and mandibular symphysis block
Further evidence that the back-pressure drops obtained by occlusion of several blood vessels represent functional anastomotic pathways was obtained from radiographic observations during perfusion of the left mandibular artery at various known perfusion pressures. Perfusion at 100 mm/Hg pressure for 70 seconds of thorium dioxide into the left mandibular artery was sufficient to visualize radiographically the right mandibular artery, its venous drainage, and the mental branch (Fig. 6). There was no evidence of crossing over at this perfusion pressure. During perfusion pressure of 115 mm/Hg (Fig. 7), thorium dioxide entered the symphysis and passed across into at least two vessels which entered the symphysis from the floor of the mouth. Perfusion at a pressure of 180 mm/Hg (Fig. 8) allowed the thorium dioxide to pass from the right mandibular artery and fill vessels located along the labial side of the left mandible. Perfusion at 200 mm/Hg allowed the thorium dioxide to fill the left mandibular artery and its mental branch as well as all the vessels which were visualized at the lower perfusion pressures (Fig. 9).

DISCUSSION

The back-pressure data on 11 animals consistently indicated the presence of anastomosis between the left and right mandibular artery or collateral circulation pathways which joined the mandibular artery. The data indicated that if collateral circulation alone was responsible for the consistent back-pressure, the collateral vessel or vessels must anastomose with the mandibular artery on both sides of the mandible. This indication was first seen when the left common carotid was ligated and was followed by a subsequent drop in back-pressure in the right mandibular artery.

Further information which led to the definite indication of anastomosis across the mandibular symphysis was obtained by placing a pressure block on the left mandibular artery at the mandibular foramen while recording pressure from the right mandibular artery.

The radiographs show an anastomosis between the left and right mandibular arteries, as well as other anastomoses with the branches of the lingual and several other arteries which enter the mandible at or near the mandibular symphysis.

These data indicate that a complex of anastomotic pathways exists in the area of the mandibular symphysis in dogs. All attempts to reduce this existing back-pressure to zero by manipulation of the main arterial supplies to the area failed to produce a drop lower than an average of 53.0 mm/Hg. A drop of the back-pressure to zero was accomplished only by obstruction of the ascending aorta. Failure of the back-pressure to drop to zero following blockage of both common carotids may be explained on the basis of pressures transmitted through the vertebral arteries across the Circle of Willis and thence into the maxillary and mandibular arteries.

The absence of crossover during perfusion of thorium dioxide at 100 mm/Hg is difficult to interpret without assuming that this compound inflicts some functional insult to the tissues which it contacts. Nevertheless, the data indicate that the pressure gradient necessary to permit crossover between the left and right mandibular arteries is higher than that required to induce crossover from the right mandibular artery into the anastomotic branches of the sublingual vessels.

The functional complexity of the anastomotic connections which occur at the
FIG. 6.—Radiograph of thorium dioxide infusion into the right mandibular artery at 100 mm/Hg

FIG. 7.—Radiograph of thorium dioxide infusion into the right mandibular artery at 115 mm/Hg
Fig. 8.—Radiograph of thorium dioxide infusion into the right mandibular artery at 180 mm/Hg

Fig. 9.—Radiograph of thorium dioxide infusion into the right mandibular artery at 200 mm/Hg
mandibular symphysis offers an explanation for the continued vitality of tissues distal to severed, ligated, or functionally obstructed mandibular arteries.

**SUMMARY**

The back-pressure in the distal segment of the ligated right mandibular artery of dogs was found to average 115 mm/Hg. A back-pressure of 53 mm/Hg remained after clamping both common carotid arteries and the mandibular symphysis, and zero back-pressure could be obtained only after clamping the ascending branch of the aorta.

Numerous anastomotic blood vessels were visualized radiographically by infusion of thorium dioxide into the right mandibular artery. Crossover between the left and right mandibular arteries occurred only at perfusion pressures above 100 mm/Hg.

The presence of this anastomotic complex offers an explanation for the continued vitality of tissues distal to severed or ligated mandibular arteries following fracture or mandibular resection.

**REFERENCES**