THE INFLUENCE OF THE METHOD OF COMPRESSION ON THE VALUE OF THE TERMINAL MAXIMAL INTRA-ARTERIAL PRESSURE

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Several investigations [1-4, 6-9 and others] have been devoted to the further study of problems associated with bloodless methods of determination of the values of the individual parameters of the intra-arterial pressure. In particular, a relationship has been shown between the terminal maximal pressure and the duration of the compression, variations in the structure of the cuff, the position and thickness of the organ on which measurements were carried out. In some investigations [1-3, 10 and others] attention was directed toward the great discrepancy between values obtained by indirect and direct measurement, reaching 50 mm Hg and more. Individual authors have observed such an increase in the values obtained by indirect measurement when using different methods of testing intravascular patency (auditory, palpatory and visual).

It is therefore of interest to examine some errors of bloodless measurement with the use of different methods of compression, paying attention to the factor of resistance of the soft tissues surrounding the artery.

EXPERIMENTAL METHOD

Experiments were carried out on dogs by means of a specially developed technique, permitting sphygmography to be done by a bloodless method and determination of the terminal maximal pressure (TMP) in the central caudal artery to be made. In order to obtain the value of the TMP, compression was brought about by means of an elastic cuff (10 × 3 cm), a rigid concentric capsule as described by V. M. Chernov [5], or a capsule for exerting local pressure on the vessel. The latter was applied to the ventral surface of the tail, where the caudal artery for a certain distance is covered only by skin and subcutaneous cellular tissue. To avoid increasing the values of the TMP as a result of displacement of the capsule from the tail in the process of compression, a second capsule was applied to the dorsal surface of the tail. The two capsules were firmly joined together and were simultaneously inflated with compressed air at the same pressure. In some experiments a cuff and a concentric capsule were applied simultaneously to the animal's tail, so that their centers were 3 cm apart. The transmitter of the sphygmographic part of the apparatus was placed distal to one or both compressing devices. The arrangement of the one or two compressing devices along the length of the tail was the same in all the experiments. The sphygmograms obtained were used for observations on the degree of intravascular patency during the determination of the TMP. The pressure was read in mm of mercury.

We carried out 86 experiments on 2 dogs. In 43 experiments the TMP was determined with the aid of a cuff, in 14 by the use of a concentric capsule, in 15 with a device for local pressure on the vessel, and in 14 experiments the TMP was measured alternately by the cuff and concentric capsule. In the course of each experiment from 10 to 20 measurements were taken.

EXPERIMENTAL RESULTS

Preliminary observations showed changes in the values of the TMP in the course of the experiment and their approximate equality at the beginning of each experiment. When the mean values were being deduced in

those cases when one compressing device was used, we therefore took note of the results of the first measurements in individual experiments. If two different compressing devices were used alternately, the mean values were calculated from all the measurements in the particular experiment. The experimental results showed that

TABLE 1

Comparison of the Values of the TMP as Determined by the Cuff and Capsule

Cuff applied to the proximal part of the tail, capsule distal to the cuff				Capsule applied to the proximal part of the tail, cuff distal to the capsule			
minutes of the experiment	values of the TMP (in mm Hg) as determined by the		excess of the value of the TMP determined by the cuff	minutes of the experiment	values of the TMP (in mm Hg) as determined by the		excess of the value of the TMP determined by the cuff
	cuff	capsule			cuff	capsule	
1	140	–	18	1	–	126	16
2	–	122		2	142	–	
3	139	–	16	3	–	121	11
4	–	133		4	132	–	
5	142	–	25	5	–	120	21
6	–	117		6	141	–	
7	148	–	22	7	–	120	14
8	–	126		8	134	–	
9	137	–	21	9	–	126	10
10	–	116		10	136	–	
11	134	–	19	11	–	125	7
12	–	115		12	118	–	
Mean value	140	122	18	–	134	123	11

the TMP, determined by means of the cuff, was 138 mm; the TMP obtained by means of the concentric capsule was 123 mm, and by means of the device for local pressure on the vessel 94.6 mm. In Table 1 are shown the results of 2 experiments carried out on a dog in which the TMP was determined by two compressing devices alternately.

TABLE 2

Comparison of the Mean Values of the TMP (in mm Hg) from All Measurements in 4 Experiments Performed with the Use of the Cuff and Capsule

Experiment No.	TMP determined by the cuff situated		TMP determined by the capsule situated	
	proximally	distally	proximally	distally
1	147.6	–	–	120.5
2	–	135	126.7	–
3	–	141	127.0	–
4	140	–	–	121.0
Mean value	143.8	138	126.8	120.7
Difference in values in the two positions	5.8		6.1	

In Table 2 are shown the results of the most demonstrative experiments carried out under analogous conditions on another dog.

The determination of the values of the TMP in the caudal artery of the dog enabled the effects of different forms of compression to be compared, and also their relationship to the resistance of the soft tissues. Experiments in which only one compressing device was used showed that the TMP obtained by the use of an elastic cuff (138 mm Hg) was 15 mm higher than that obtained by the use of a concentric capsule (123 mm Hg), and 43 mm higher than the TMP determined by local pressure on the vessel (94.6 mm Hg). In the last case the counteraction of the soft tissues to the compressing force consisted only of the resistance of the vessel wall and skin covering it. With concentric compression of the vessel, in addition to the surrounding soft tissues was added the resistance of the muscles and tendons of the tail. This addition to the counteraction of the compressing force was shown by the increase in the TMP determined by the capsule, by 28 mm Hg, and measured by the cuff by 43 mm.

In the experiments in which two compressing devices were used simultaneously (see Tables 1 and 2) a relationship was revealed between the above-mentioned excess of pressure and the soft tissue resistance. When the compressing device was applied distally and proximally, the thickness of tissue compressed, by virtue of the conical shape of the tail, differed by approximately 18%. As a result of this, the values obtained when the compressing device was situated distally were reduced: by 5.8 mm for measurements with the cuff, and by 6.1 mm for measurements with the capsule. Hence, by a rough calculation, the resistance of the whole mass of soft tissues at the point of measurement may be determined. If the thickness of the diaphyseal part of the vertebra in the region where the compression was applied accounts for 20% of the cross section of the tail, then to overcome the resistance of all the soft tissues requires about 26.5 mm Hg. The TMP with local pressure on the vessel (94.6 mm) plus the calculated value of the resistance of the soft tissues (26.5 mm) amounts to 121 mm. This value is close to that obtained in experiments using the concentric capsule, and is 17 mm less than the TMP determined by the cuff in the corresponding position of the tail (138 mm).

On the basis of the experimental findings described it may be concluded that the values of the terminal maximal intra-arterial pressure by bloodless measurement are increased by the resistance of the soft tissues surrounding the caudal artery of the dog to the compressing force. The degree of this increase depends on the mode of compression used.

SUMMARY

The terminal maximal intra-arterial pressure was determined in the tail arteries of dogs with the aid of an elastic cuff, concentric capsule and a device for exerting local pressure on the vessel. Different compression devices were used separately and in pairs, with the change of their location on the tail in conformity with the difference in the thickness of soft tissues subjected to compression. It was experimentally demonstrated that the compression measurement of the terminal maximal blood pressure is accompanied by some exaggeration of the data received. This exaggeration is connected with the resistance of the soft tissues, the extent of which depends on the method of compression.

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