Lesson of the Week

Inaccuracies in measuring tourniquet pressures

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Since Roman times the surgical tourniquet has been used to arrest blood flow in a limb.¹ Initially they were applied to stop severe haemorrhage either due to injury or as a result of emergency amputation. Since the middle of the nineteenth century they have been used during elective surgery.

Any fault in the gauge measuring the pressure of the inflatable cuff may cause problems. Firstly, too low a reading may result in excessive pressure on the limb and cause local tissue damage or nerve palsies. Secondly, too high a reading may allow blood to flow into the wound—so increasing the difficulties of the surgical procedure—and, in the case of intravenous regional analgesia, allow a large bolus of local anaesthetic to enter the circulation.²⁻³

The commonest gauge in use in operating theatres is of the Bourdon type (figure). They are accurate and robust, but unlike a mercury manometer it is not immediately obvious if they are damaged or have become inaccurate. For this reason they must be tested regularly,⁴⁻⁸ as recommended by the manufacturers. Realising that I had never seen a tourniquet gauge checked or

The pressure gauges of tourniquets used during anaesthesia and surgery should be checked at least monthly to ensure that their measurements are accurate

heard the method described in detail, I decided to conduct a survey of tourniquet gauges in London and determine both the accuracy of the gauges and whether the theatre staff knew how to test them.

Method

In 18 months I visited 17 hospitals in London and tested all the tourniquet gauges either in use in operating theatres or available for immediate use in the theatre cupboards. Four of the hospitals were teaching hospitals, three district hospitals, two postgraduate specialist hospitals, and eight private hospitals. I did not disclose the reason for my interest in tourniquets until arriving in the operating theatre so as to obtain a true picture of the state of the tourniquets in use. For most measurements I used my own mercury manometer which had been previously serviced and checked for accuracy. On some occasions I used the hospitals' own mercury manometers having tested them against other equipment.

Determining accuracy—To test the gauge of the tourniquet the tubing that normally inflates the cuff is connected directly to the tubing leading to the mercury manometer of a sphygmomanometer which reads up to 300 mm Hg. The tourniquet control unit is adjusted until its gauge registers 100 mm Hg, and the reading on the mercury column is then recorded. This is repeated at settings of 200 and 300 mm Hg. A small selection of plastic tubing and connectors should be kept to join the various tubing junctions that are in use. Some manufacturers sell dial type "master gauges" for checking the tourniquets but since these rely on the same type of gauge they must also be checked for accuracy against a mercury manometer. They have the advantage, however, that pressures higher than 300 mm Hg can be tested directly, but this is not strictly necessary as faulty gauges nearly always have a uniform error throughout their range owing to their simple mechanisms, and tourniquet pressures greater than twice systolic are not necessary for most limbs.¹⁻⁹ Routine checking should also look for leaks, damaged or insecure connections, faulty controls, and worn out cuffs.

Defining inaccuracy—Gauges with an error of at least 20 mm Hg at a setting of 200 mm Hg (an error of 10%) were taken to be inaccurate. At least one manufacturer of a popular tourniquet system recommends that the cuff pressure for an arm should be only 25 mm Hg above systolic pressure, so an accuracy of 20 mm Hg does not seem unreasonably stringent.

Type of gauge commonly used with surgical tourniquet equipment to measure the pressure of the inflatable cuff.

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Results

The 17 hospitals I visited had 62 theatres containing 66 tourniquet gauges. I tested 65 of the 66 gauges at three or more different settings between 100 and 300 mm Hg (table I). The gauge tested at only two settings had an error of 170 mm Hg at each of these settings. For this gauge readings above the 100 mm Hg setting were impossible to record as the true pressure exceeded the capacity of my sphygmomanometer. Any error present was a constant absolute amount rather than a proportional error (table II). Thus the percentage error was greater at lower than at higher pressures. For each gauge I calculated the maximum difference in absolute error between its readings. For all the gauges the mean of these differences was only 9 mm Hg, though the actual errors ranged from 0 to 230 mm Hg.

Thirty per cent of the gauges were inaccurate, some to such an extent that they were immediately withdrawn from use. In only one hospital did the theatre staff regularly check the gauges, and when asked they were the only ones who knew how to do it. Their gauges were accurate.

Table III shows the makes of tourniquet apparatus tested. The larger proportion of inaccurate gauges in the older types of equipment was probably due to the lack of maintenance over many years rather than to any inherent fault in design.

TABLE I—Number of tourniquet gauges tested at different settings between 100 and 300 mm Hg

No of gauges tested at (settings):					Total
2	3	4	5	6	
1	32	26	6	1	66

TABLE II—Sample of readings from two tourniquet gauges compared with those of a mercury manometer

Pressure shown (mm Hg) by:		Error
Gauge	Mercury manometer	
(A) 100	32	+68
150	84	+66
200	146	+54
250	180	+70
300	244	+56
Maximum difference in error		16
(B) 50	168	-118
100	212	-112
140	260	-120
Maximum difference in error		8

TABLE III—Results of checking the accuracy of gauges belonging to tourniquet equipment according to the manufacturer

Manufacturer	No	No (%) faulty
Kidde	31	9 (29)
Zimmer	18	9 (50)
Schuco	8	1 (12.5)
Stille	3	0 (0)
Zimmer 855	4	1 (25)
Scala	1	0 (0)
Accoson	1	0 (0)
Total	66	20 (30.3)

Discussion

Until this survey (ended May 1982) the advice of many authorities¹⁻⁸ and the medical defence societies¹⁰ was clearly not being followed, and gauges were not being checked before operations or at a minimum every month. Surgeons should satisfy themselves that the tourniquet equipment they use is

checked at least monthly and preferably more often. They should be able to show their theatre staff the method of testing the gauges, which takes only five minutes. Only a mercury manometer should be used as some of the dial gauges on anaesthetic machines and in some recovery wards are themselves inaccurate.

The gauge on a tourniquet system is only one component of the several parts that must be seen to be working efficiently. A system of selecting equipment, training users, and servicing¹¹ should be established and reviewed regularly in hospitals to ensure maximum safety for the patient.

I thank Riker Laboratories for servicing and checking the mercury manometer.

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(Accepted 20 January 1983)

Clinical pointer: availability of folic acid

I am often asked if vitamin preparations containing folic acid are available without a doctor's prescription. The answer seems to depend on whether the preparation is promoted for medicinal or nutritional purposes. All preparations containing folic acid and listed in *MIMS* are available on prescription only. Vitamin products supplied by health food manufacturers are available over the counter and by mail order. Used as suggested by the manufacturers most of those containing folic acid provide amounts ranging from less than 1 µg to more than 1 mg daily, but folic acid 5 mg tablets can also be purchased. The amounts of vitamins in some non-medicinal supplements are worrying. A product currently advertised contains vitamin A 25 000 IU and vitamin D 1000 IU in each tablet, with 26 other ingredients.—R W SMITHELLS, professor of paediatrics, Leeds LS1 3ET.

Clinical curio: threadworms—a rare case of perianal abscess

A previously well 11 year old boy presented with a history of recurrent perianal abscesses. Six weeks before admission one perianal abscess discharged spontaneously. A further abscess then appeared. The patient had not complained of pruritus ani. At operation numerous live threadworms (*Enterobius vermicularis*) were found at the dentate line within the anal crypts and in the lower rectum. An intersphincteric abscess was drained and 15 non-motile threadworms were found in the cavity. The intersphincteric space was laid open, and the patient was treated with piperazine. He made an uncomplicated recovery. Mixed colonic organisms were cultured from the abscess. Histological examination of the abscess wall showed an acute inflammatory response and a number of threadworm ova. The association between perianal abscess and threadworms has not been previously reported. We suggest that in schoolchildren presenting with a perianal abscess parasitic infestation of the lower gut should be carefully excluded.—NEIL J MCC MORTENSEN, lecturer in surgery, and JAMES P S THOMSON, consultant surgeon, London.