

The Rhys-Davies exsanguinator

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Summary

A simple device for limb exsanguination is described. It is quick and easy to use, effective and safe, and appropriate to a wide range of circumstances. Strain-gauge plethysmography has been used to measure its efficacy and shows that it is better than limb elevation alone and comparable to use of the Esmarch bandage.

Introduction

The Rhys-Davies exsanguinator is an inflated elastic cylinder (Fig. 1). It is rolled onto a limb to produce exsanguination as shown in Fig. 2. In use it requires no external monitoring equipment. It is easy to maintain: it can be washed in soap and water or antiseptic solutions, but not autoclaved. The degree of inflation, which may be affected by stretching of the elastomer with time, or changes in ambient temperature, can be checked by feel or by measuring the external circumference. Reflation, and direct measurement of the inflation pressure, is simply done via a needle through a valve in the wall and a sphygmomanometer (Fig. 1).

The Rhys-Davies exsanguinator was used on fifty unselected consecutive orthopaedic patients prior to surgery; ease of use and effectiveness of exsanguination were documented. Exsanguination was usually satisfactory, even when problems might be anticipated, such as with very large or very small limbs, or with Bier's block anaesthesia.

With the size currently marketed, it is impossible to roll the exsanguinator onto a limb with a circumference much above 60 cm. Nevertheless exsanguination is generally adequate when the sleeve has been rolled as far as possible onto a very fat or muscular thigh. As the exsanguinator is rolled onto a limb, the pressure within the sleeve increases as the volume of the enclosed limb increases. With small limbs, the rate of increase of pressure as the sleeve is rolled on is small and hence the extent of exsanguination can be expected to be less. Again, this is rarely a practical problem. When using Bier's block anaesthesia exsanguination must be started by elevating the limb, exsanguinating the arm to the upper cuff if the double cuff technique is used, so that the minimum of blood remains in the limb to dilute the anaesthetic, otherwise in open surgery troublesome oozing may occur.

One particular advantage of the device is that it can be used over open wounds or fresh fractures, when the combination of traction on the limb during application and the smooth roll-on of the sleeve ensures that no additional trauma is inflicted.

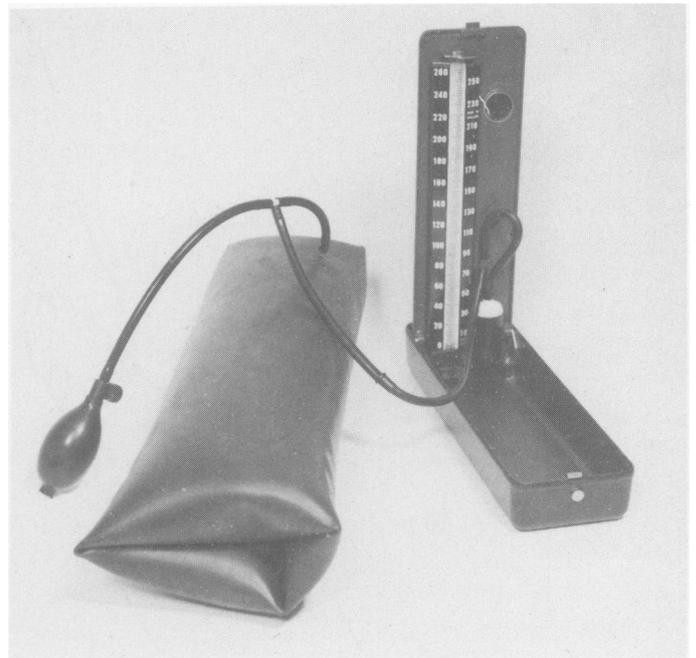


FIG. 1 The Rhys-Davies exsanguinator, showing a needle inserted into the valve in its wall, connected to an inflation bulb and manometer via flexible tubing.

Experimental studies

METHODS

Changes in upper limb volume of healthy volunteers were measured indirectly by measuring changes in circumference using a strain-gauge plethysmograph. The effects of elevation for three minutes, use of the Rhys-Davies exsanguinator in the recommended fashion, or exsanguination with an Esmarch bandage, were compared. To avoid inaccuracies due to movement artefacts, degree of exsanguination was estimated by comparing minimum circumference after exsanguination with the baseline after deflation of the tourniquet cuff (Fig. 3).

In a separate experiment, measurements of the pressures imposed on a limb during active exsanguination were obtained by taping small fluid-filled bladders onto the skin, each connected to a manometer.

RESULTS

Fig. 3 shows three typical plethysmograph traces superimposed for comparison: the Rhys-Davies device produced

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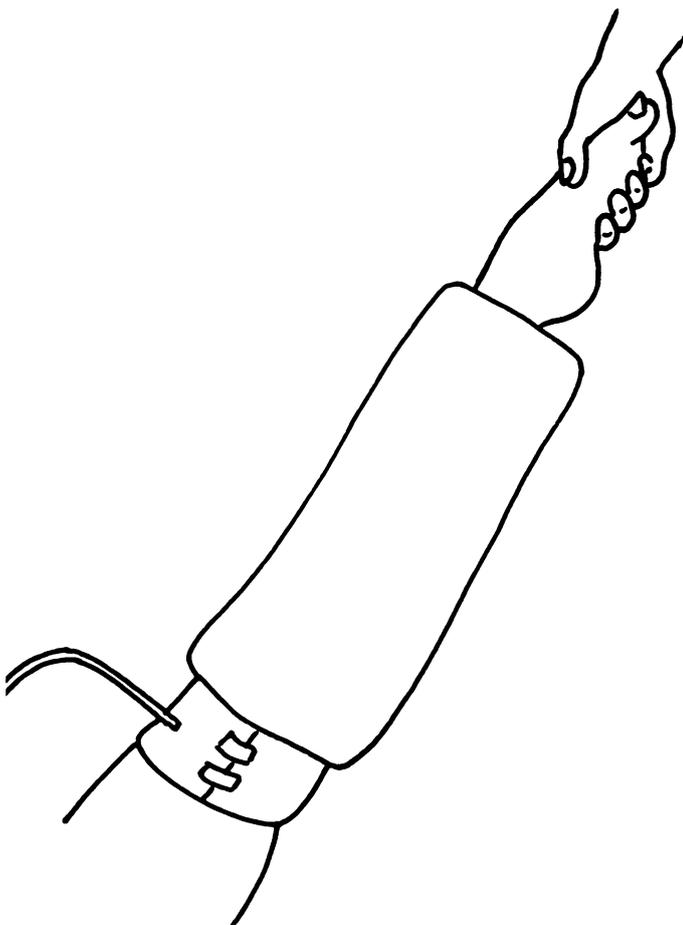
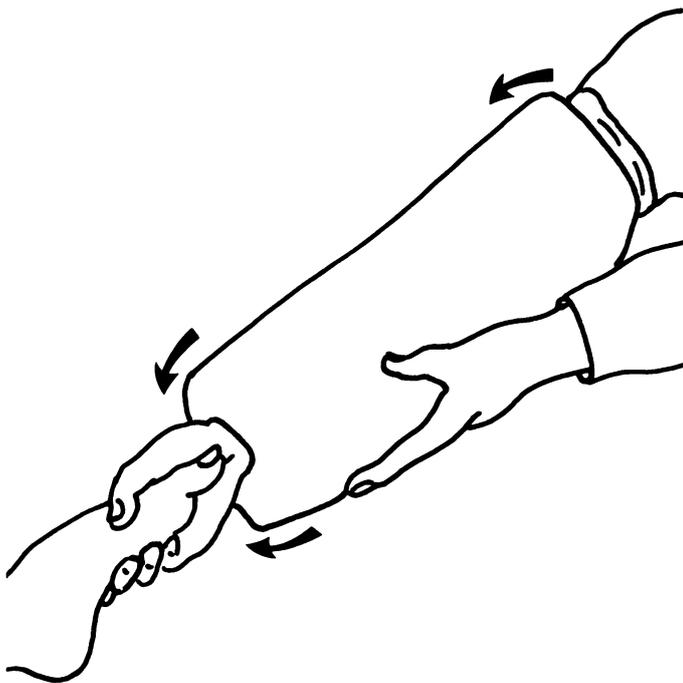


FIG. 2 Application of the exsanguinator: the patient's limb is elevated for one minute and the exsanguinator is rolled onto the operator's arm; he then grasps the patient's hand or foot and, while exerting steady traction, rolls the exsanguinator onto the limb. When the exsanguinator has been rolled up to the level of the padded tourniquet cuff, the cuff is inflated and the exsanguinator rolled off the limb.

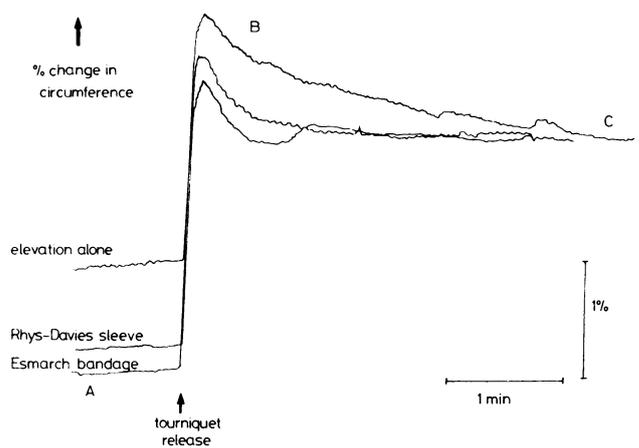


FIG. 3 Superimposed plethysmograph traces; three different exsanguination methods. (A) is the steady state circumference after exsanguination; the tourniquet is released and after a transient increase due to reactive hyperaemia (B) the circumference returns to normal (C).

greater exsanguination than elevation alone, but not as great as that produced by an Esmarch bandage, vigorously applied. Fig. 4 shows the means and standard deviations of the percentage circumference changes achieved with the three exsanguination methods. Elevation alone is significantly less effective than either of the other methods ($P < 0.001$).

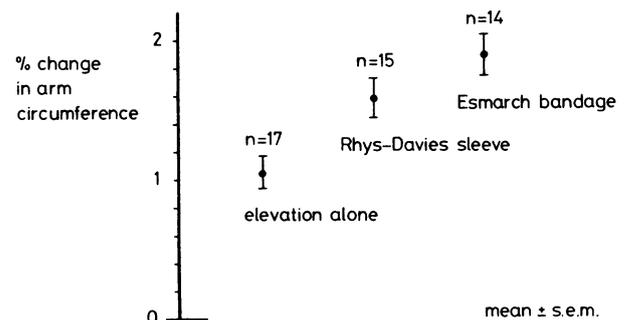


FIG. 4 Mean \pm standard error of the mean of the percentage limb circumference changes produced by three different exsanguination methods.

In the upper limb, pressures in the region of 200–300 mmHg were regularly measured during application of an Esmarch bandage. This reflects the average applied pressure over the area of the bladder and will probably be a underestimate of the forces generated at the edge of the bandage. The Rhys-Davies exsanguinator cannot produce localised ridges of high pressure, or appreciably distort the superficial soft tissues of a limb. Even on the largest limb the maximum pressure generated is about 150 mmHg, and this is nearly uniformly distributed over the whole enclosed surface of the limb. Higher pressures are not possible since the stretched circumference of the sleeve limits its progression up a large limb, while the bulk of the exsanguinator surrounds the narrower distal parts.

Discussion

The Esmarch bandage efficiently expresses blood from a limb. However its application is strenuous and time-consuming, it is painful for a conscious patient, it is difficult and damaging when used over broken bones, and it has been thought that the soft tissue distortion produced by the "heel" of the applied bandage may occasionally be responsible for nerve damage (1–4). Thus there is a need for a simple, easily-used, atraumatic exsanguination device. Such is the Rhys-Davies exsanguinator. It has been in clinical use for

some years and where it is available, theatre staff prefer it to the Esmarch bandage because of its ease, convenience and comfort in use. It seems likely that high pressures and localised soft tissue distortion can cause significant damage. The Rhys-Davies device is thus intrinsically safe, since it generates neither. There have been no reported complications of its use.

Exsanguinators were supplied for clinical and experimental work by Woodville Polymer Engineering Ltd., Heathcote Road, Swadlincote, Burton-on-Trent DE11 9DX.

The late Mr A J Harrold kindly allowed his patients to be studied, and encouraged the reported clinical studies.

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Notes on books

Gastric and Gastroduodenal Motility edited by L M A Akkermans, A G Johnson and N W Read. 332 pages, illustrated. Praeger, Eastbourne. £16.

This is an authoritative book on gastroduodenal motility as it relates to the practice of gastroenterology and gastric surgery. It contains contributions from internationally recognised surgeons, physicians and basic scientists and attempts to provide the research worker with an up to date review and to enable the clinician to evaluate his patient's symptoms both before and after operation in order to choose the appropriate treatment.

Endocrine Problems in Cancer edited by Roland T Jung and Karol Sikora. 318 pages, illustrated, paperback. Heinemann London. £17.50.

The aim of this book is to review the endocrine and metabolic problems that can arise in malignant disease, stressing practical advice for help in diagnosis and management. The book is directed at clinicians who manage patients with cancer.

Replacement of the Knee by Richard S Laskin, Robin A Denham and A Graham Apley. 222 pages, illustrated. Springer, Berlin. \$58.30.

Written by three surgeons, each with extensive experience in the treatment of knee joint disease, this book covers the current state of the art of total knee replacement. Present knee joint design is evaluated in the light of successes and failures of the early total knee prostheses. Biomechanical factors that influence the selection of prostheses are fully discussed. An important book for those surgeons practising in this field.

NMR—Tomography of the Normal Brain by Günther Gademann. 91 pages, illustrated. Springer, Berlin. \$36.60.

Depicting the advantages of NMR imaging of normal head anatomy over the more conventional CT scan, the superb plates in this book will interest neurosurgeons, ENT surgeons and oral surgeons as well as radiologists and anatomists. How Henry Gray would have loved this volume!