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The calibration of flask press spring loads for studies on the properties of denture base resins.

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SUMMARY

A simple technique is described for the rapid and accurate calibration of flask press spring loads for studies in which denture base resins require to be processed under uniform loading conditions. The technique was evaluated in commercially available flask presses and was found to perform with a high degree of precision. It offers a simple solution to the problem of standardising flask press loads in experimental studies on denture base materials.

OPSOMMING

Hierdie ondersoek handel oor 'n tegniek vir die kalibrering van die veerdruk van die kunsgebit drukpers, waardeur die vervaardiging van kunsgebit akrielbasisse onder gelykvormige ladings kan geskied. Die tegniek is met beskikbare drukperse op die proef gestel en het besonder akkuraat gewerk. Hierdie tegniek bied 'n eenvoudige oplossing vir die probleem om drukpersladings tydens eksperimentele ondersoeke van kunsgebit akrielbasisse te standardiseer.

INTRODUCTION

Intra-flask pressures have been shown to be an important factor in the production of physico-mechanically and clinically acceptable denture base resins (Tuckfield, Worner and Guerin, 1943; Eriksson, 1973). A wide range of spring loads have, however, been employed in the processing of these resins. Flask press loads, used in previously reported studies, range from 180 - 490kg. (Anderson, 1972; Tuckfield *et al*, 1943). It would seem to be important that consideration should be given to the standardization of flask loads in any comparative studies which are undertaken to determine the effects of processing methods on the physical properties and surface characteristics of heat cured polymethylmethacrylate denture resins.

No commercially obtainable spring loaded flask presses are available which can be used to deliver specified loads within the range quoted by Anderson and Tuckfield. The purpose of this paper is to describe a simple modification of a commonly used commercially available flask press to enable the spring load to be calibrated to deliver a specified load with a high degree of precision for evaluatory studies on denture base resins.

MATERIALS AND METHODS

Within the elastic limit of any body the ratio of the stress to the strain produced is as constant as has been confirmed by Hooke's Law (Schaum and Van der Merwe 1966). The degree of extension and compression of a spiral spring is, therefore, proportional to the load which is applied. It should be possible to use the principle for calibrating flask press spring loads so that denture base resins may be heat cured under comparable conditions. To examine this possibility a method was devised to enable the degree of compression of the pair of spiral springs which support the lower compression plate in commercially produced flask presses to be measured in response to the application of a standardised load.

Five new flask presses* were used in this study. The presses were modified to enable measurement of the distance travelled by the spring loaded lower pressure plate in response to the application of a standardised load. This movement was measured by means of a dial guage** to the nearest 0,01 mm.

The dial guage was mounted on a bracket to enable it

* Hanau No. 2 Flask Press - Teledyne, Hanau, Buffalo, New York, U.S.A.
** No. 2046-08 Mitutoyo Manufacturing Co. Ltd., Tokyo, Japan.

to be positioned on the base of the flask press with the dial gauge plunger orientated at right angles to the spring loaded lower pressure plate. Two holes were drilled and tapped in the base of each of the flask presses to enable the dial gauge bracket to be mounted in a position that would allow the plunger of the dial gauge to pass through an existing hole in the base of the flask press frame and make contact with a pin which was attached to the spring loaded lower pressure plate of the flask press (Fig. 1). This pin was attached midway between the two compression springs by means of a countersunk head screw which passed through the lower pressure plate (Fig. 2). The free end of the pin was centre-drilled to provide a shallow recess in which the anvil of the dial gauge plunger could be seated to enable recordings of base plate movements to be made during the load calibration procedures.

LOADING OF FLASK PRESS SPRINGS

A tensile testing machine* was used for loading the compression springs of the flask presses. The tensile loading mode was converted to a compression loading mode by using the inner frame of a compression cage accessory of the machine**. The clamping screw of the upper pressure plate of each of the flask presses was removed. This provided a convenient threaded hole which was used to attach the frame of the flask press to the lower mounting socket of the tensile testing machine by means of a specially constructed threaded plug. This plug was screwed into the flask press frame and inserted in the lower mounting socket of the tensile testing machine. The plug was then secured in the mounting socket by means of a transverse connecting pin (Fig. 3).

The inner frame of the compression cage was suspended from a pre-calibrated 500kg load cell*** which was mounted in the moving crosshead of the tensile testing machine. The base plate of the compression cage was unbolted from the four corner columns of the compression cage, and the crosshead dropped to enable the plate to be passed beneath the springloaded lower pressure plate of the inverted flask press frame. The compression cage base plate was then bolted to the corner columns of the compression cage. With this arrangement, vertical movement of the crosshead progressively loaded the flask press springs. The dial gauge, fixed to the base of the flask press was accommodated between the arms of the compression cage and the movement of the spring-loaded baseplates could be accurately recorded (Fig. 4).

CALIBRATION OF SPRING LOADS

Preliminary tests on each of the 5 flask presses indicated that the maximum load which could be supported by the springs beneath the base plates was a little in excess of 190 kg. A spring load of 175 kg was then arbitrarily adopted as the standard load against which the movement of the base plate was to be calibrated.

To test for correlation between the compression of the baseplate springs under a standard load, each of the flask presses were mounted in the testing machine 10

* Instron Table Model Type 1026, High Wycombe, England.
** Instron Compression Cage G63-2.
*** Instron Load Cell 1026DM.

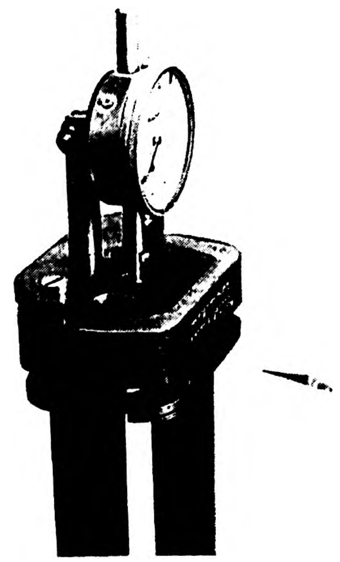

Fig. 1 Oblique view of a dial gauge mounted on a flask press showing the dial gauge plunger passing through a hole in the flask press base in order to record baseplate movement.

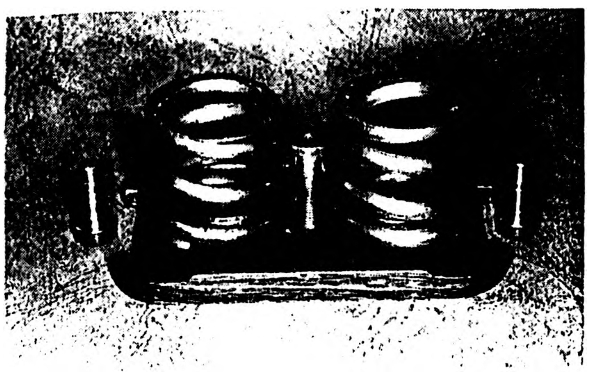

Fig. 2 The lower pressure plate and springs of a flask press showing the pin between the springs which transmits the baseplate movement to the anvil of the dial gauge.

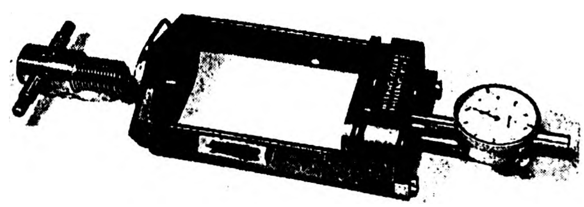

Fig. 3 The threaded plug, flask press and dial gauge assembly used for the calibration procedure.

times in random order and the movement of the spring loaded baseplates in response to the application of a 175 kg load was determined by means of the dial gauge.

From the 10 readings obtained from this procedure the mean distance moved by the baseplate under the standard load of 175 kg was calculated for each of the 5 presses.

The 5 flask presses were then again tested by progressively loading each of the spring loaded baseplates, and recording the load which produced the respective amount of mean spring compression for each baseplate movement which was determined in the previous procedure. Ten recordings were also carried out in random order for each flask press. The standard deviations and coefficients of variation were calculated for the two procedures for each of the 5 flask presses.

RESULTS

The results obtained for the mean distances moved by the baseplates of the five presses under the standard load and the mean loads which had to be applied to each of the respective presses to produce the mean amount of baseplate movement are detailed in Tables I and II.

With the application of the standard 175 kg load a coefficient of variation of between 0,15 – 1,72 per cent was recorded in the movement of the spring loaded baseplates of the 5 flask presses. When the mean baseplate movements of the 5 flask presses was effected respectively by means of the tensile testing machine, a range of coefficient of variation of 0,7 – 1,1 per cent was found in the loads generated by the baseplate springs.

DISCUSSION

This study was designed to test the correlation between the compression of the flask press springs and distance travelled by the spring loaded baseplate in order to establish whether the latter parameter may be used to calibrate flask press loads for experimental studies on the properties of denture base resins. The results of the study indicate that the calibration of flask press loads in relation to the amount of compression of the lower pressure plate springs may be used with a high degree of precision for the application of a standardised load to flasks used for the processing of heat cured resins.

The results indicate, however, that the amount of spring compression may vary between presses and each press needs to be individually calibrated with the application of a standardised load. This method is inexpensive and simple to apply and should enable investigators to standardise flask loads with a high degree of precision for experimental studies.

It is not known at this stage whether the amount of usage of flask presses or the exposure of the springs to boiling water will alter the elasticity of the springs in the flask presses with time. The calibration method is however easy to apply and it is recommended that the calibration standard for each flask press be checked at regular intervals during an experimental study.

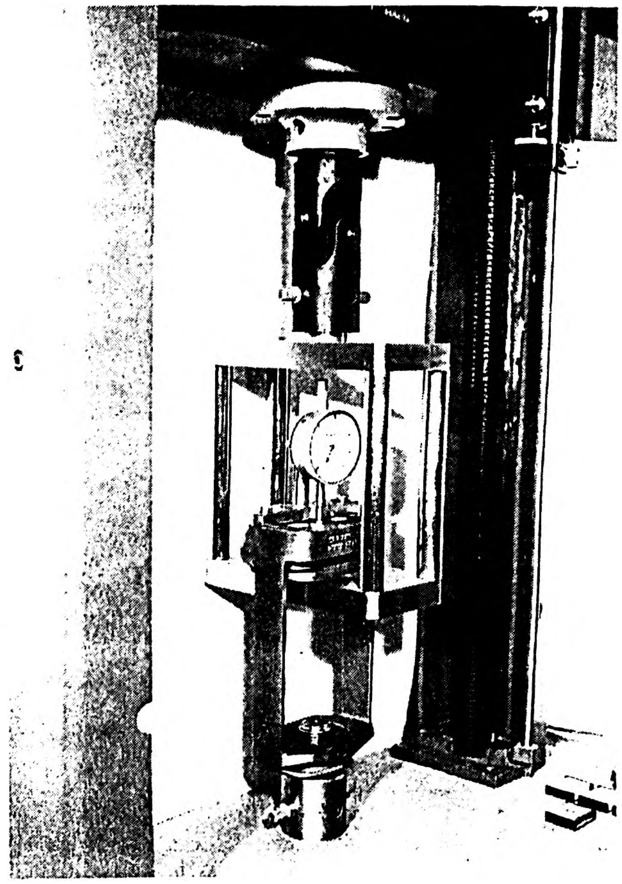

Fig. 4 The flask press mounted in the tensile testing machine with the compression cage loading the flask press pressure plate.

Table I The mean baseplate movement recorded in millimeters in response to a 175 kg load.

	Press I	Press II	Press III	Press IV	Press V
$\bar{x}$	4,56	5,80	4,37	3,29	3,44
SD	0,02	0,10	0,05	0,01	0,01
Coefficient of Variation (per cent)	0,44	1,72	1,14	0,24	0,15

Table II Mean load recorded in kilograms in response to the respective mean baseplate movement recorded in Table I.

	Press I	Press II	Press III	Press IV	Press V
$\bar{x}$	174,9	172,8	174,5	174,3	174,5
SD	1,0	1,8	1,1	1,8	1,9
Coefficient of Variation (per cent)	0,6	1,1	0,7	1,0	1,1

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