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# METHOD OF STABILIZING AUTOPSY SPECIMENS IN BIOMECHANICAL EXPERIMENTS

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In reproducing trauma acting on major parts of fresh autopsies, one of the experimental problems to be overcome is the method of fixing the specimens in the desired positions. So far, the skeletal parts have been anchored mostly in vices, although sometimes the bone ends have been nailed, screwed to metal plates, or fixed in special devices built in or close to the compression machines.

The stability obtained by the above methods was usually insufficient, due to the fact that cortical bone does not withstand such fixations, it breaks or becomes loose, and cancellous bone does not give enough support, it softens and gives away.

To obtain improved stability we have tried several imbedding procedures, *i.e.*, low fusion point metals, plaster of Paris, plastic materials and unfilled polyester resins. None of these materials, however, proved satisfactory, either because of long setting times, insufficient adhesion to the specimen due to its moisture content, or inability of the material itself to withstand the forces applied. All these difficulties prevented us from studying different types of mechanical forces to the extent we want. The complexity of questions in analyses of the spine and the joints in regard to traumatic lesions where forces have to act from different directions could not be experimentally approached. Since we are very fortunate in getting fresh cadaveric material for biomechanical purposes, we were prevented from exploiting our facilities. An adequate method of fixation would open up a wider field for experimental work.

More than a year ago we were fortunate in finding what we feel to be the best method tried so far. This involves using a polyester based mastic, intended mainly for the repair of automobile bodies and for filling and jointing purposes both domestically and industrially. It

consists of two components, a liquid and a powder. The liquid is a modified polyester resin-containing accelerator. The powder consists of chemically inert fillers, which enhance the mechanical properties of the polyester and also contains a peroxide catalyst which causes a mixture of the two components to set to a hard mass, as a result of the polymerization of the polyester.

The setting time depends on two factors; firstly the fixing ratio of the components, the more powder, *i.e.*, peroxide used, the faster the setting time. A thick paste will give a setting time of about 8 minutes, while a thin paste such as might be used to fill cavities or very uneven surfaces will take up to 15 minutes to set at room temperature. Temperature is the second factor involved. The polymerization of polyesters is retarded at temperatures below 15° C, and considerably accelerated as the ambient temperature increases.

The polymerization reaction that occurs is exothermic and the temperature attained by the setting mastic depends on the bulk being used, but does in our experiments not exceed handling limits or affect the bone ends.

The mastic used by us can be moulded to any shape or form, and shortly after setting can be machined or drilled as desired.

In practice the bone ends of fresh cadaveric material are left for about ten minutes in a mixture of acetone and ether to remove the moisture on the outer surfaces, and after drying for a few minutes placed in the freshly mixed mastic in the mould, and then left undisturbed until the setting time is over.

The moulds used are cube shaped and have been specially machined to fit our testing devices, and in order to use them many times certain preparatory procedures have to be followed to permit release of the mastic from the mould, at the conclusion of the experiment.

The mould surface must be absolutely clean and free from traces of hard mastic. Washing with ethyl acetate is usually sufficient. The mould must now be treated with a release agent which can take the form of wax, lecithin/petroleum jelly mixtures, silicone solutions or even thin sheets of polythene or cellulose. In our work a thin layer of wax is applied to the inner surface of the cleaned mould, followed by a brushed coating of silicone solution. To facilitate easy removal of the mastic from the mould two holes have been drilled in the bottom to allow pressure to be applied to the set mastic itself. For the very best release from the mould, the surfaces should be highly polished and as free from surface imperfections as possible. The mastic used here has

been formulated to have the best possible adhesion to metal surfaces for its normal use, and great care must therefore be taken over the application of the release agent.

The mastic has not interfered in any way with the experiments, the amount of material to hold the specimens is very small. Lesions in the "holding area" do not seem to occur since the distribution of forces at the point of fixing is spread over an area that can be adjusted with regard to the forces involved in the experiment. In the study of fracture mechanism in some experiments more than a thousand kilograms are used. The anchoring of the specimens has been sufficient even when bending and torque has been applied.

In evaluating bony operating procedures such as arthrodeses, osteotomies and spinal fusions it is highly desirable to perform autopsy experiments in order to test the mechanical response to various methods. So far it has only been possible to check osteosyntetic devices with regard to immediate stability. To get fused specimens for biomechanical analysis is rarely possible unless one starts animal work. Again then the premises are completely different.

The mastic we have used can be adopted as a bone glue which may to some extent simulate callus. Bone grafts can be applied, osteotomy surfaces can be jointed and different types of arthrodeses performed in backs and joints in autopsy material and tested with respect to mechanical efficiency.

## SUMMARY

Different stabilizing procedures in biomechanical experiments in autopsy material have been studied. The purpose is to fix bone ends of joints and spines in order to apply different types of forces until fractures or other lesions occur in order to analyse the underlying mechanism of traumatic lesions. The aim has also been to study the mechanical efficiency of spinal fusions, arthrodeses and osteotomies with regard to different techniques.

The best method tried so far for fresh autopsy bones has been a mastic consisting of two components, a liquid of a modified polyester resin containing accelerator, to be mixed with powder of a chemically inert filler which enhances the mechanical properties of the polyester and also contains a peroxide catalyst, which causes a mixture of the two components to set to a hard mass. This is the result of the polymerization of the polyester.

The application is discussed and technical experiences presented. It

is strongly felt that this method of fixation opens up a wider field for laboratory experimentel orthopaedics from which clinical knowledge can be obtained.

RESUME

Différents procédés de stabilisation ont été examinés au cours d'expériences biomecaniques de matériel d'autopsie. Le but était de fixer les extrémités des os dans les articulations et la colonne vertébrale afin d'appliquer différents types de forces jusqu'à ce qu'il se produise une fracture ou d'autres lésions pour pouvoir analyser le mécanisme déterminant des lésions traumatiques. On avait en outre aussi l'intention d'étudier l'efficacité mécanique des fusions vertébrales, des arthrodèses et des ostéotomies en ce qui concerne différentes techniques.

La meilleure méthode essayée jusqu'ici pour les os d'autopsie fraîches a été un mastic formé de deux composants, un liquide d'une résine polyester modifiée contenant un accélérateur à mélanger à une poudre de remplissage chimique inerte rehaussant les propriétés mécaniques du polyester et contenant aussi un péroxyde catalyseur, qui produit le mélange des deux composants de manière à former une masse dure. C'est le résultat de la polymérisation du polyester.

Cette application est discutée et des expériences techniques sont présentées. On a bien l'impression que cette méthode de fixation ouvre un large champ auf expériences orthopédiques de laboratoire d'où des connaissances cliniques pourrent être tirées.

ZUSAMMENFASSUNG

Verschiedene stabilisierende Verfahren wurden in biomekanischen Versuchen an einem Autopsiematerial untersucht. Es war die Absicht Knochenenden von Gelenken und Wirbelsäulen zu fixieren und verschiedene Kraftarten zu verwenden bis Brüche oder andere Beschädigungen auftraten um den zugrunde liegenden Mechanismus traumatischer Schädigungen zu analysieren. Die Absicht war es auch die mechanische Leistungsfähigkeit von Wirbelverschmelzungen, Arthrodesen und Osteotomien unter Berücksichtigung verschiedener Techniken zu studieren.

Die best bisher an frischen Autopsieknochen versuchte Methode ist eine Mastixlösung, die aus zwei Komponenten besteht, einer Flüssigkeit eines modifizierten Polyesterharzes, das einen Accelerator enthält und mit dem Pulver eines chemisch inaktiven Füllstoffes gemischt

wird, der die mechanischen Eigenschaften des Polyesters steigert und auch einen Peroxid Katalysator enthält, welcher bewirkt dass die Mischung beider Komponenten eine harte Masse ergiebt. Dies ist das Ergebnis der Polymerisierung des Polyesters.

Die Anwendung wird besprochen und technische Erfahrungen werden gegeben. Man ist überzeugt, dass diese Fixierungsmethode ein weites Feld für die experimentelle Laboratoriumsorthopedie eröffnet, von der klinische Erkenntnis erhalten werden kann.

## ACKNOWLEDGEMENT

The mastic we have used is sold in Sweden under the name of Plastic Padding. It can naturally only be used in cadaveric experiments.

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