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TISSUE LAXITY AND ITS INFLUENCE ON POWER OF MUSCLE

By

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The degree of hardness which a muscle expresses during palpation through the covering soft tissues has long been termed tonus or tone.

There has been a great deal of discussion about this term, however. As early as 1931 *Sherrington* (1) claimed that the word "tonus" should be dispensed with since it embraces far too many different concepts. Nevertheless, it is still in use, particularly in clinical circles. *Reichel* (2) argues that the term "Ruhespannung" is more adequate. Against this, the objection can be raised that it is difficult to achieve a state of complete rest. Special attention must be devoted to the position of that part of the body where the muscle tone is to be appraised. Using, for example, a standing individual to asses and compare the distribution of muscle tone in symmetrical segments of both halves of the body can lead to serious errors, if an uneven distribution of the body weight over the lower extremities is not taken into consideration.

There are diverse opinions, meanwhile, on the nature of the muscle's resting tension. *Landowne & Stay* (3) define tonus as "a long continued state of tension in a muscle, maintained by activity of the contractile elements". This corresponds most closely to the idea that tissue tension and its variations have their equivalents in gels of varying viscosity. In contrast to this "active" theory there is the more "passive" theory which upholds the decisive importance of the tissue elasticity in the muscle fibres and in the connective tissue around the sarcolemma and between the fibres where it, in the form of endo-perimysium, intertwines and surrounds the muscle. It has long since been established that this network of connective tissue, in intimate contact with the contractile element of the muscle, affects the mechanics of the muscle.

Braus (4) describes the connective tissue as the *skeleton* of the muscle and says of the septa which intertwine the muscle that "sie verhindern die Faser über eine maximale Grenze anzuschwellen ohne die Dehnung des Muskels in der Längsrichtung zu hemmen". *Hill* (5) maintains that "the main deformation of active muscle takes place in the passive series' elastic element" and *Ramsay* (6) also emphasizes the great importance of the interstitial tissue in the total elastic condition of the muscle. *McKinley & Berkwitz* (7) consider that regard must be paid to the muscle fibres' own elasticity and that a great deal in the matter of tonus is not attributable merely to a reflex mechanism by proprioceptive reflexes. *Adams–Denny Brown–Pearson* (8) maintain that atrophic muscle fibres which do not properly fill their connective tissue capsules give the impression of being hypotonic musculature, just as well-trained muscles with large muscle fibres which thoroughly fill out their connective tissue capsules give the impression of possessing good tone.

The nervously conditioned state of the muscle is transmitted by a somatic spinal reflex arc. The receptor organs are primarily those stretch receptors which are found in the muscles (muscle spindles) and tendons (Golgi organs) and from which afferent impulses reach the spinal cord, via the dorsal roots. Through their poles the muscle spindles often make contact with the muscle fascia or the perimysium, the intramural extension of which as endomysium intertwines the muscle both in its longitudinal direction and at right angles to it.

The clinician quite often encounters patients with a manifestly low rest tension in their muscles. As a rule this condition is accompanied by a general softness of the tissues and by joint flaccidity. Varying attention has been directed to this within the different branches of medicine; often enough, however, it is treated in the reports as a curiosity. Most articles on the subject are by dermatologists and neurologists. But this form of muscle hypotonia is probably of greater significance in orthopaedics than in any other branch of medicine. Hypotonic patients constitute a large percentage of orthopaedic cases. Papers on the subject by orthopaedists, meanwhile, are not very numerous.

Based on material from the Dept. of Physiotherapy at the Karolinska Sjukhuset, *Andersson & Silfverskiöld* (9) have discussed the question of what they call "the flaccid joint type", though without going into its causes. In an orthopaedic publication *J. & R. Hass* (10) have contributed a paper on the same subject, though once again without attempting to analyse the causes. They have called congenital joint flaccidity "arthrochalasis multiplex congenita". These authors likewise point out that this interesting clinical phenomenon has been sadly neglected in orthopaedic literature. The French clinical journals describe joint flaccidity principally as "laxité ligamentaire", while in German journals we encounter the term "die konstitutionelle Bänderschwäche", the sufferers of which, "die Bänderschwächlinge", reveal all manner of postural deformities of a statical origin due to gravity and loading, besides varices and herniae. The ability of these patients to stretch their joints excessively has given rise to the terms "Fingerkünstler" and "double-jointed people". Another term often encountered in the English-language publications is Ehlers-Danlos syndrome, which is a collective clinical term for the different forms of tissue laxity. There are three clinical manifestations of the classical syndrome, 1: laxitas cutis, or cutis hyperelastica where the skin can be lifted up into large folds, 2: laxitas articulorum, sometimes demonstrating grotesquely stretchable joints, 3: a curious frailty of the skin, dermatorhexis, which makes it very difficult to stitch a wound or incision in such a patient, since the stitch simply breaks through the skin instead of holding it together. On healing the wounds of these patients often leave an ugly, keloid-like scar. This third part of the syndrome, however, ought to be rather seldom met with.

Tissue softness and joint flaccidity is remarkably heredo-familial. The hereditary course has not been fully clarified. It would seem that both sexes are equally affected.

The joint flaccidity with abnormally large amplitudes of movement results in poor stability of the joint. This instability, sometimes assuming the proportions of transient subluxations, predisposes to incongruence of the joint facets and eccentric wear of the joint cartilages.

Those authors who consider that muscle hypotonia and joint flaccidity cannot be attributed solely to disorders in the neuro-muscular reflex mechanism turn as a rule to an inferior mesenchyma for the cause. Mesenchymos, fibrodysplasia or fibrodystrophia have been put forward as explanations. This theory has support by the fact that children suffering from joint flaccidity often reveal blue sclerae, a condition thought to result from an anusually thin atrophic-dystrophic sclera which permits the pigment-rich and blood-rich choroid to show through and give the sclera its blue shade. Histological studies of the skin, connective tissue and musculature of patients with tissue softness and joint flaccidity have not revealed any particular departure from the normal. In cases of Ehlers-Danlo's syndrome some authors have revealed, through electronmicroscopic studies, certain fine-structured differences, for example in the intertwining of the collagenous and elastic fibrils. No definite evidence has been put forward, meanwhile, that there is any pathological significance attached to this. *Dammermann & Müller* (11) put forward as a reason "die Spannungsverlust und die Überdehnbarkeit der kollagenen Fasern . . .. welche in Elektronmikroskop nachgewiesen werden konnten". The authors talk of "Tonus des kollagenen Gewebes" and mean here presumably the physical properties and qualities of the connective tissue. If the points of view concerning muscle tone were extended to embrace the tonus of the connective tissue as well, *i.e.* the physical properties, such as elasticity and stretch, then the problem could only be dealt with from a biomechanical angle of approach.

Whether we regard the neuro-muscular theory as sufficient explanation for tonus, and somatic or functional disturbances of a most complicated, psychically modulated reflex mechanism as the reason for muscle tone disturbances, or prefer to regard the phenomenon as a matter of the tensile strength, say as a matter of quality, of the connective tissue in different individuals—or whether we consider that both these theories can be combined, possibly through a neuro-hormonal link, the problem as a whole has so many practical-clinical aspects that any form of investigation in this field is bound to be watched with interest.

AUTHOR'S INVESTIGATIONS

In an effort to acquire figures on the magnitude and variations in the hardness of muscles, where rest tension is a basic component, the following experimental method was worked out:

A plastic ring with an outer diameter of 2 cm and an inner diameter of 1 cm and a thickness of 1 cm was fastened with a special glue on to the skin, over the muscle intended for examination. A small piston was inserted into the 1 cm hole. The piston was secured by two springs fixed in two diametrically opposite situated holes on the outer side of the ring (Fig. 1). By means of the springs it was possible to bring a light pressure to bear so that the piston was pressed in against the skin. When the muscle contracted, giving rise to varying states of hardness, the piston was pushed upwards to an extent that depended upon the degree of contraction. The plastic ring was also raised, of course, when the muscle contracted, but through the way in which the initial position was set—with the piston slightly pressed against the skin inside the ring, it was possible to register the difference in the position of the

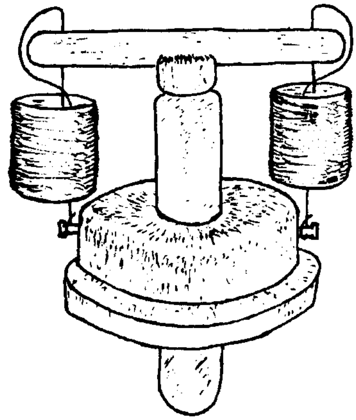

Fig. 1.

piston in relation to the carrying surface of the plastic ring during the different contraction states of the muscle.

This method, however, was found to have certain complications which were difficult to overcome. One of these was of a technical nature: to find a dependable glue with a suitable joint. If the joint was somewhat elastic, the ring was more securely firm against the skin, but on the other hand this elastic layer between the skin and the under surface of the ring took up too great a part of the upwards pushing force from the piston during the muscle's contraction, which naturally made it impossible to use this sort of glue. Of the different types that were tried Eastman 910 proved to be the most adequate although due to the relatively frail joint it was not possible to leave the test patient to his own devices for a prolonged time without risk of the plastic ring loosening. It was reckoned that through relatively long-term tests it would be possible to assemble information on the assumable changes in the degree and duration of the muscle's hardness. This, of course, would call for a continuous registration of the course.

When using this method for comparing results from different individuals the elasticity of the skin is one of the most important factors. If the skin is extremely elastic a considerable degree of the measurement range is lost.

The degree of skin elasticity, which varies according to the individual, may be regarded as also representative of conditions in other connective tissue in the individual. The significance to muscle mechanics of the muscle's own connective tissue has already been pointed out. On the observation that extensive stretchability of the skin made my method less accurate, it occurred to me that the elasticity factor might be of some significance to the degree of force deriving from a muscular contraction. In other words it is possible that extensive elasticity leads to a loss of power during a muscular contraction. Mechanically this could be explained by extensive elasticity in the connective tissue permitting excessive bending or deflection of the muscle fibres; the more peripheral in the muscle, the greater the loss. Apart from this presumably unfavourable displacement in the direction of force of the muscle fibres, resulting from their deflection, there are also certain hydraulic aspects of the way in which the muscle works, assuming that the contractile element is regarded as a viscous mass or gel contained in a connective tissue capsule. The degree of effect in this system would be upset if the "cylinder walls" were too extensible. Both for the vascularisation of the muscle and for the setting in action of the self-regulator or the servo-steering, in respect to the reflex-activated tension which the muscle spindle mechanism is reckoned to represent, a certain degree of elasticity is of course required, though we can assume that there should exist an optimum for this. In the case of individuals with a pronounced degree of tissue softness, clinically defined as hypotonic patients, it is possible that the resistance met by the contractile mass of the muscle is too low and thus not optimal. Previous investigations have not been able to prove that the reason for hypotonia is to be found somatically in defective muscle spindles or terminal nerve endings (12) or functionally in a defective nervous innervation.

Brown (13) claimed during a test on the M. retractor penis of a tortoise that if the muscle was made to contract against a compression of 270 atmospheres the singular isometric twitch doubles. The reason for this was thought to be that through the counter-pressure the contractile phase was prolonged.

The planning of the continued investigation was carried out with a view to finding out what effect elasticity in the soft tissues surrounding the muscles might have upon the magnitude of the power derived from a muscular contraction.

METHOD

There are certain difficulties attached to finding a muscle or a group of muscles suitable for what one intends to study. As a rule the force output at the joints is a summation effect of several muscles. Thus, for example, the force involved when the sole of the foot presses down on a plate is the result of the efforts of more muscles than just the M. triceps surae. For my investigations I selected the thenar group.

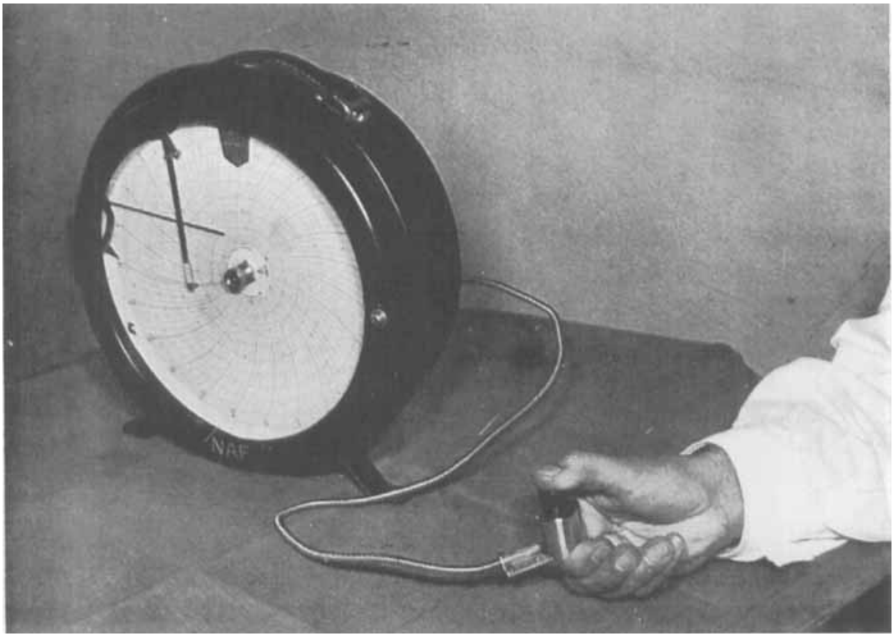

Fig. 2.

These muscles have a fairly selective effect upon the small joints. The risk of irrelevant addenda of any significance from other muscles is negligible. As a working test I selected the grip made by the thumb when its terminal phalanx is pressed against the radial side of the forefinger's middle phalanx. This pinching action makes great demands of the thenar musculature. When performing this grip the effect of the thumb's long flexor can be regarded as a constant component. The fingers are held semi-flexed and the forefinger is supported against the remaining fingers (Fig. 2). The pressure is conveyed to an elastic bellows via a spherical button, and the counter pressure via a concave grooved part of the under surface of the button, supported on the middle phalanx of the forefinger. From the bellows the pressure is hydraulically transmitted to a pressure receiver and registering instrument[1]. The instrument is fitted with a printer which shows the pressure variations, also as a function of time, by means of a graph which is rotated by electricity (Fig. 2). The design of the take-up components gives the best possible assurance that for each patient the same lever is used during both parts of the experiment, as per below, and also that direction of the applied pressure is the same in both parts of the experiment. The patient is requested to exert maximum pressure. The above experiment, as pointed out, is divided into two parts. One where the thenar musculature is permitted to swell freely, and one where this is restricted as per below. A hindrance to the muscle's spontaneous configuration changes during the contraction can be

[1] This equipment was manufactured by A.B. Nordiska Armaturfabrikerna, Linköping – Stockholm, under the registration number NAF 32700.

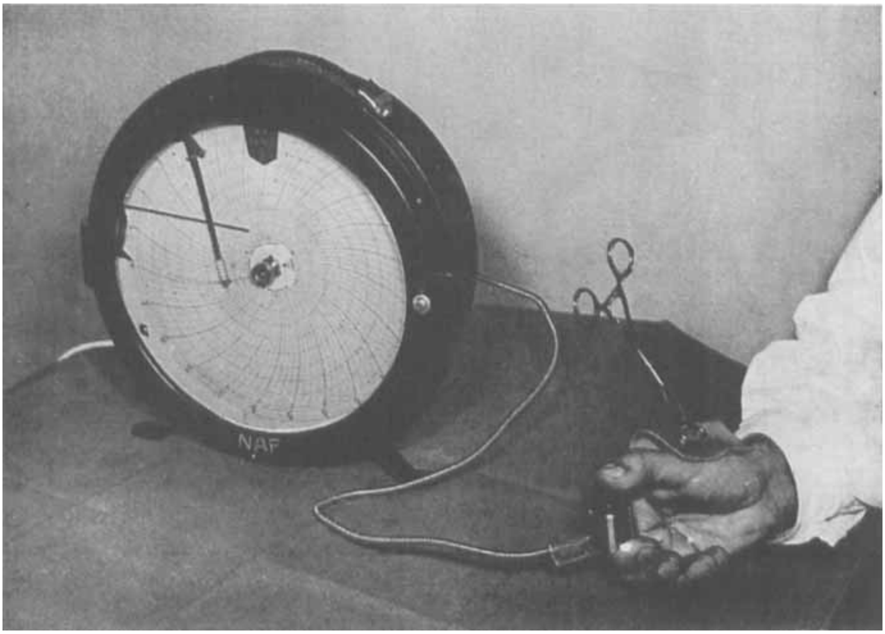

Fig. 3.

achieved by decreasing the tissue space within which the muscle, in different sized units of contractile masses, swells. Collectively all these spaces constitute the muscle's real compartment. Reduction can be achieved through lessening the size of the tissue capsule which takes part in the stretching action when the muscle contracts. Only the peripheral capsule around the muscle, *i.e.* the skin, is of course available for such a measure for in order to reduce the muscle fascia as well, an operation would be necessary.

The reduction of the skin is achieved as follows: A thin rubber sheet is placed on the skin dorso-radially to the thumb's metacarpal bone. The skin and its accompanying rubber sheet is lifted up in a fold, parallel to the metacarpal bone. One or a couple of pairs of grooved tongs of the type employed in anesthesiology to draw the tongue forwards are used to lift up and secure this fold (Fig. 3). The object of the rubber sheet is to protect the skin. It is of course not possible to avoid a certain slipping of the raised skin during the contraction of the muscle. The patients were not informed beforehand of the object of the experiment which was described simply as a study of muscle physiology.

Since the degree of variation in muscle power during the two existing experimental conditions may be so slight that it can escape detection in a rested muscle through the method described, the experiments were carried out on fatigued muscles. The fatigued muscle has very little reserves of power left and consequently it is more sensitive to changes in its normal environment. The patients thus began by making a series of pinching actions during the experiment with a request to maintain a constant pressure level as long as possible. The apparatus was so placed that it could only be read by the person directing the experiment. By studying the graph made by these introductory tests the fatigue progress could be watched and when this reached a suitable level the test was begun. The two phases of this, with and without stretched skin, followed directly after each other, the only interval between being the time needed to lift up the fold of skin with the protective rubber sheet and apply the pair of tongs. Two such complete experiments were made on each patient. There was the same interval between the final preliminary fatiguing test and each phase of the experiment. In order to test the theory—of a connexion between the resistance met by a muscle during its contraction and its power—as severely as possible the stretched skin phase was always the latter one.

The following points must be strictly observed if the experiment is to be correctly carried out:

1. The patient must participate whole-heartedly and do his utmost all along. This is a prerequisite of the entire method.

2. The same grip must be maintained on the pressure-giving apparatus throughout the experiment, even when the skin fold is raised and the tongs secured. This does not mean of course that the muscle should not be relaxed when the patient is not actually engaged in the pinching action. The pinching action, furthermore, should not be abrupt and intense, it should be gentle and persistent.

3. A proper change in the size of the muscle compartment must be achieved. This means that the raised fold of skin shall be as large as possible and must remain in a raised position by means of a steady grip with the tongs. A certain problem may arise here insomuch that this procedure may hurt or trouble the patient somewhat, despite the protective rubber sheeting, causing him to reduce the strength of his effort. The patient should thus be questioned on this point.

The necessity of being able to change sufficiently the conditions around the muscle in phase II of each experiment means that a normal patient cannot be used, since the normal individual does not have sufficient "surplus" skin.

MATERIAL

The investigation was carried out on human subjects. These were not selected, beyond the rejection of individuals who were either too old or too retarded mentally to be capable of co-operating in the procedure, or who showed unsatisfactory passivity during the investigations and who were generally adjudged to be unlikely to co-operate.

The material comprises 15 individuals, 10 females and 5 males, selected at random from the comparatively large group of people who clinically reveal tissue laxity. As a criterion here laxitas cutis and laxitas articulorum were chosen. In no case was the former the result of rapid loss of weight. The ages of the patients varied between 14 and 67.

RESULTS

The results of the experiments are shown in Table 1. Some diagrams are shown in Figs. 4–6.

The circular diagram which has a circuit time of 4 minutes shows along the radial arcs pressure in cm^2 and periphery time. The distance between the concentric circles represents 0·1 kg and the smallest peripheral scale unit 2·5 seconds. In the objective appraisal of the measurement results comparisons have been made between the output amplitudes, *i.e.* the maximum pressure value shown in each part experiment. Here the quarter values are adjusted to the nearest 1/2 or 1/1 unit value; upwards in the parts without tongs and downwards with. Amplitude has been measured from the nearest common 1/2 or 1/1 circle, and is shown in the column headed "without" for the parts without tongs and in the column headed "with" for the parts with tongs. d means the difference between the measured amplitudes. 1 and 2 refer to the first and second sets of experiments respectively. M_d means the arithmetical mean value of d_1 and d_2. The electric motor was stopped between each phase in the experiment and thus the time intervals between the phases are not shown on the diagram.

TABLE 1

Patient	Sex	Age	Without$_1$	With$_1$	Difference$_1$	Without$_2$	With$_2$	Difference$_2$	Mean difference
I	♀	20	2.5	2.0	—0.5	1.0	2.0	1.0	0.25
II	♀	17	1.5	3.0	1.5	0.5	6.0	5.5	3.50
III	♀	51	1.0	1.5	0.5	4.5	5.5	1.0	0.75
IV	♀	67	2.0	2.5	0.5	1.0	2.0	1.0	0.75
V	♀	61	2.5	5.0	2.5	2.5	5.5	3.0	2.75
VI	♀	44	4.0	6.0	2.0	5.0	5.0	0.0	1.00
VII	♂	47	0.5	2.0	1.5	2.0	3.5	1.5	1.50
VIII	♂	48	3.0	5.5	1.5	5.0	6.5	1.5	1.50
IX	♀	28	2.0	5.0	3.0	3.5	5.0	1.5	2.25
X	♂	14	5.0	5.5	0.5	2.5	3.0	0.5	0.50
XI	♂	54	4.5	6.0	1.5	4.5	5.5	1.0	1.25
XII	♀	53	2.0	6.5	4.5	1.5	2.0	0.5	2.50
XIII	♀	32	5.0	7.0	2.0	4.5	7.0	2.5	2.25
XIV	♀	39	4.0	6.0	2.0	3.0	4.5	1.5	1.75
XV	♂	28	3.5	5.0	1.5	2.0	2.5	0.5	1.0

For each patient there is a number of measurements which show a certain variation both during the preliminary fatiguing test and during the main experiment. This is explainable biologically. Meanwhile on account of the arrangement of the experiment two of these measurements belong to a certain class "without tongs" and two to a class "with tongs". If the arrangement of the experiment was of no importance to

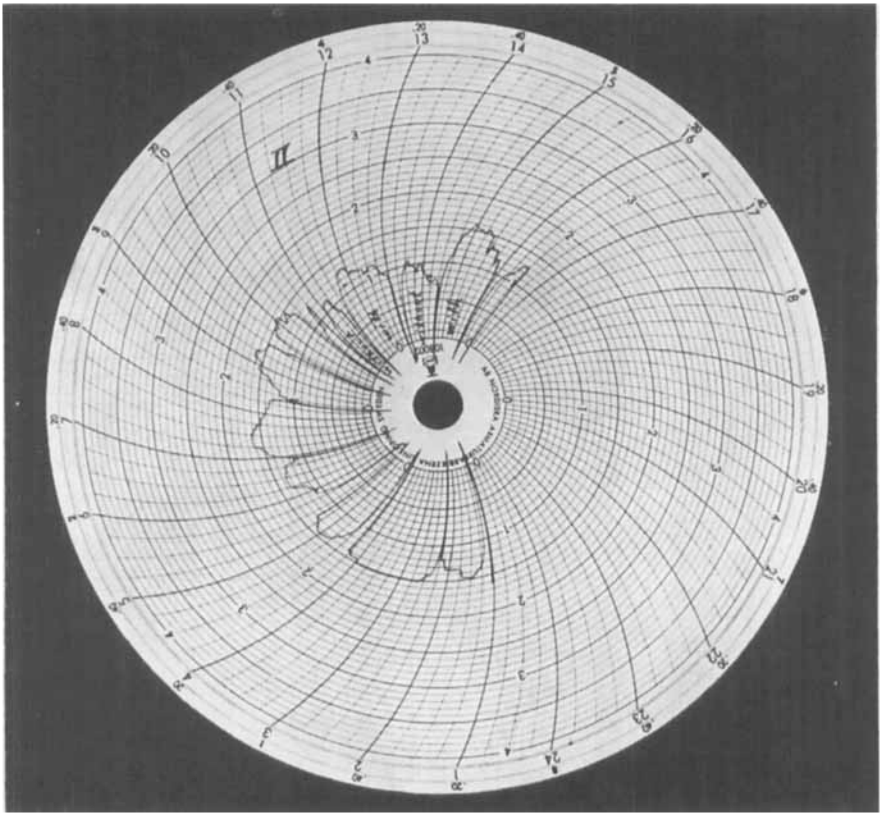

Fig. 4.

the measurement values the difference between the mean figure for "without tongs" and the mean figure for "with tongs" would vary at random about 0, *i.e.* in the long run equally many positive and negative differences could be expected. In a sample group of 15 individuals there were 15 plus values, which by chance occurs only once in 32768, *i.e.* approx. 0·00003 ($2^{-15} \approx 0{\cdot}00003$).

DISCUSSION

The investigation has shown that in the case of the hypotonic individual if resistance is set to the muscle during its contraction, thus restricting its swelling, then its effect increases. The change in the muscle's environment brought about by the investigation method would not seem to be such that the subsequent conditions differed from the

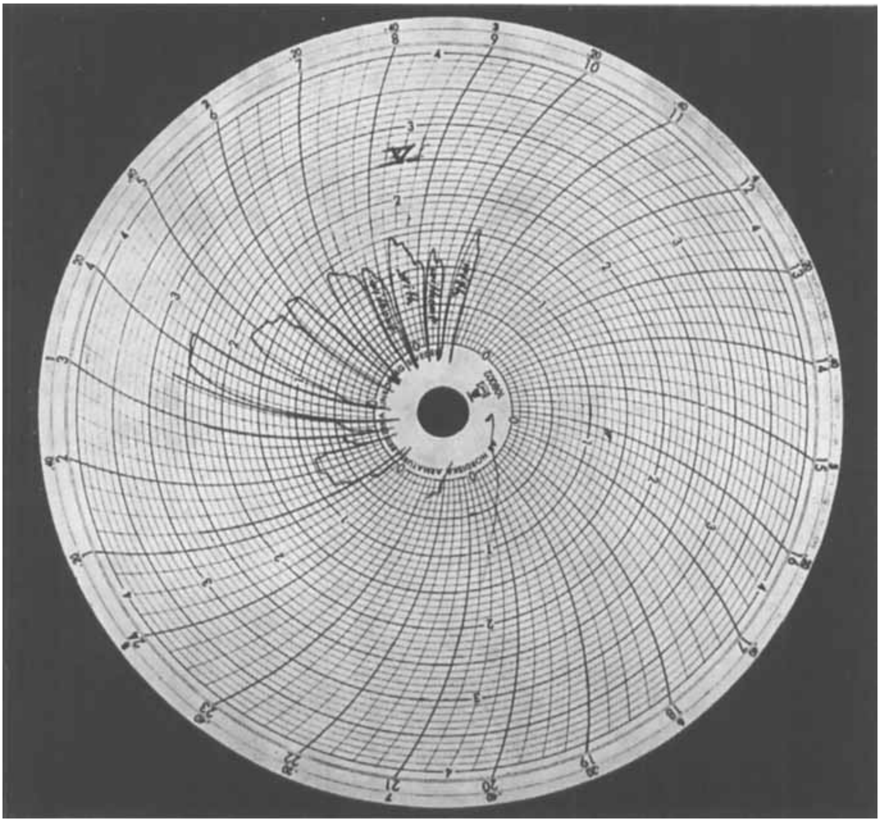

Fig. 5.

conditions regarded as normal in non-hypotonic patients. The exogenously achieved changes in pressure in the muscle compartment should, within certain limits, bring about an increase of muscular effect in any individual. The resistance to the muscular contraction, determining the pressure values within the muscle compartment should not, of course, be so great that the circulation and nervous status of the muscle and its surroundings is impeded. An optimal pressure value in the muscle compartment, corresponding to each single performance, and an integrated elasticity optimum for the entire muscle compartment is conceivable. In hypotonic individuals the elasticity factor in this respect would not be optimal but rather too great, whereby their muscles would have to work constantly against too low a resistance. The method in the ịnvestigation whereby the presumable pressure increase in the muscle compartment was achieved, implied in practice a decrease

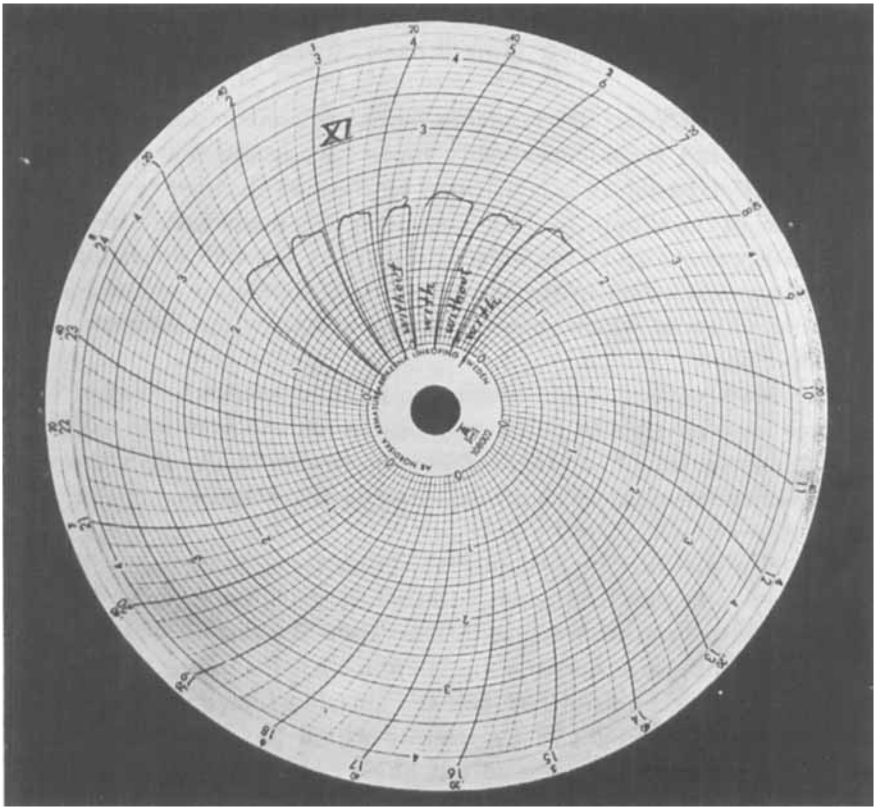

Fig. 6.

in the muscle compartment's volume. This assumes that the term muscle compartment is used in its broadest sense, implying all the tissue spaces affected by the configuration changes which occur during muscle contraction. The method of raising the skin can be said to compensate for one of the most obvious clinical manifestations of the hypotonic patient, *i.e.* "surplus" skin. There is no reason to assume that it would be an advantage for the non-hypotonic if his muscle compartment were restricted. From being an advantage for hypotonics a limit is passed where the longterm effect of pressure increase becomes negative in the non-hypotonic individuals.

It cannot be assumed that the raising up and pinching of the skin would, through a change in the proprioceptive reflexes, decrease the threshold for stimulation of the muscle and result in an increase in the muscle's effect. In experiments it has not been possible to bring about an increase in the muscle's effect merely through pinching the skin, without at the same time holding it back during the contraction of the muscle.

That effect increase derives from increased contraction power in the muscle and not from conceivably more favourable power directions over the affected joints is confirmed by the fact that lesser changes in the degree of the thumb's rotation, changes of a magnitude which might conceivably accompany the holding off of the skin, do not bring about any increase of effect in the muscle during the course of the test, the pinching action of which consists mainly of opposition between thumb and forefinger.

On a basis of the way in which the method has been worked out it has not been possible to derive any figures on the pressure within the muscle compartment or on the degree of stretch in the skin above the muscle in the two phases of the experiment. Investigations in this direction will continue.

In view of the fact that people exhibiting tissue laxity are very often considered to be psychasthenics and that they display increased fatigue, it would have been interesting to have used the test to get an idea of their endurance, in order to see if there is any difference in endurance between the two conditions around the muscle which existed during the experiment. In the light of the results which have been derived it is not unlikely that the increased weariness can be ascribed, at least to some extent, to muscle mechanics. As can be seen from the diagrams, however, planimetric or other comparisons between surfaces would lead to absurd conclusions. This is because the threshold values for giving up, *i.e.* the time factor, varies so greatly from individual to individual. It is impossible to demand of a patient such a maximal, prolonged tension as would be required for the test to give reliable endurance values. Furthermore, the revival time, if the test was also to be used as an endurance criterion, would be so prolonged that further false sources would seriously upset its course and interfere with the process of making comparisons of the muscle activity during two different conditions around the muscle.

CONCLUSION

In his investigations the author has only desired to show that in patients exhibiting tissue laxity an increased resistance to muscular contraction—within the limits established by the experiment—seems to result in increased momentary effect. The attached diagrams are not intended to give detailed information.

The clinical evaluation of the results should be made carefully. Apart from the suggested connection between asthenia and increased fatigue and the findings which have been made, it is possible that the unquestionably favourable effect of the corset in cases of spinal insufficeency is not only a result of the immobilizing effect of the corset. It is likewise possible that in certain branches of physical sports empirically derived experience (for example the fact that among weight lifters a body belt can improve performance) may have a genuine basis.

SUMMARY

In individuals presenting tissue laxity and softness (people belonging to the clinical cadre of subjects with Ehlers–Danlos syndrome, also termed "Bänderschwächlinge" or said to exhibit "laxité ligamentaire") experiments have been made on their power of muscle contraction.

The muscle, or group of muscles, under investigation has been the thenar musculature, and the function test a pinching action of the thumb against the forefinger.

The pressure thus evoked has been transmitted directly to, and registered by, an apparatus, and the course has been visualized on a graph by means of a printer.

The maximum contraction force of the muscle has been investigated in respect to two melieus:

1. during normal conditions
2. when the muscle during its contraction has been prevented from swelling freely by lifting up a fold of skin in the immediate vicinity of the muscle and holding this fold steady back during the muscle contraction, thus attaining a sort of shrinking of the muscle compartment —if this latter word is considered in its broadest sense.

It would seem that this latter procedure—in conditions existing during the experiments, and in individuals presenting tissue laxity—will produce a greater contraction power of the muscle. The reasons for this fact are discussed.

RESUME

Des expériences ont été faites concernant le pouvoir de contraction des muscles chez des individus présentant une laxité et un défaut de tension des ligaments (appartenant au cadre clinique des sujets pré-

sentant le syndrome Ehlers–Danlos, aussi appelé « Bänderschwächlinge » ou que l'on dit manifester une « laxité ligamentaire »).

Le muscle ou le groupe de muscles sur lequel ont porté les recherches appartient à la musculature du thénar et le test fonctionnel a consisté dans le pincement du pouce contre l'index.

La pression ainsi provoquée a été transmise directement à un appareil d'enregistrement et la courbe a été visualisée sur un graphique au moyen d'un marqueur.

La force maximum de contraction du muscle a été examinée dans deux relations:

1. dans des conditions normales,
2. alors que l'on empêchait, durant sa contraction, le muscle de gonfler librement en soulevant un pli de la peau dans le voisinage immédiat du muscle. En maintenant ce pli durant la contraction du muscle, on obtient alors une sorte de rétrécissement du compartiment du muscle, ce terme étant pris dans son sens le plus large.

Il semble apparaître que cette dernière manière de procéder – dans les conditions des expériences et chez les individus présentant une laxité des tissus – produit un pouvoir plus fort de contraction du muscle. Il est discuté des raisons de ce fait.

ZUSAMMENFASSUNG

An Personen, die Gewebsschlaffheit und Weichheit aufwiesen (Leute, die zur klinischen Gruppe mit Ehlers–Danlos Syndrom, auch „Bänderschwächlinge" genannt oder zur sogenannten „laxité ligamentaire" gehören), wurden Versuche hinsichtlich ihrer Muskelkontraktionskraft ausgeführt.

Der Muskel, oder die Muskelgruppe, welche untersucht wurde, war die Thenarmuskulatur und die Funktionsprobe war die Druckwirkung des Daumens gegen den Zeigefinger.

Der in dieser Weise hervorgerufene Druck wurde direkt auf einen Apparat übertragen und mittels demselben registriert, und der Verlauf wurde mit Hilfe eines Druckers graphisch sichtbar gemacht.

Die grösste Kontraktionsstärke des Muskels wurde unter Berücksichtigung zweier Versuchsbedingungen untersucht:

1. Unter normalen Verhältnissen.
2. Wenn der Muskel durch die Aufhebung einer Hautfalte in der unmittelbaren Umgebung des Muskels und durch ständigen Zug an der Falte während der Muskerkontraktion in seiner uneingeschränkten

Schwellung verhindert war. Auf diese Weise erhielt man eine Art von Schrumpfung des Muskelfaches – wenn man den letzteren Ausdruck in seiner weitesten Bedeutung versteht.

Es scheint, dass das letztere Vorgehen – unter den vorliegenden Versuchsbedingungen und bei Personen, die Gewebsschlaffheit aufwiesen – eine grössere Kontraktionskraft des Muskels hervorbrachte. Die Gründe für diese Tatsache werden besprochen.

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