



**ORTHOCURE MEDICAL CENTER (DUBAI, UAE)
REHABILITATION KINESIOLOGY TRAINING (DUBAI, UAE)
MEDICAL KINESIOLOGY ACADEMY (MOSCOW, RUSSIA)**

INSTRUMENTAL VERIFICATION OF MUSCLE WEAKNESS IDENTIFIED DURING MANUAL MUSCLE TESTING

Prof. Ludmila Vasiljeva



RELEVANCE

Between 37 - 64,7% of the population suffers from muscular pain of various severity (V.V. Alekseyev, 2022).





TREATMENT METHODS

Injections,
Stretching shortened muscles,
Anesthesia





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CONTRADICTING THE LAWS OF NEUROLOGY

When the peripheral nervous system is affected, nerves get compressed

- Hypotonia,
- Hypoesthesia,
- Hyporeflexia
- occur in the affected muscles





REASONS FOR THE EXISTING CONTRADICTION

Myotatic reflex activity can be evaluated with the help of a tendon **hammer**. Yet, diagnosis can be performed **only at rest**. There is **no instrument** for clinical diagnosis of myotatic reflex activity under load.



MANUAL MUSCLE TESTING

- **Assessment of the ability of the nervous system to adapt the contractility of an isolated muscle to the increasing isometric load**



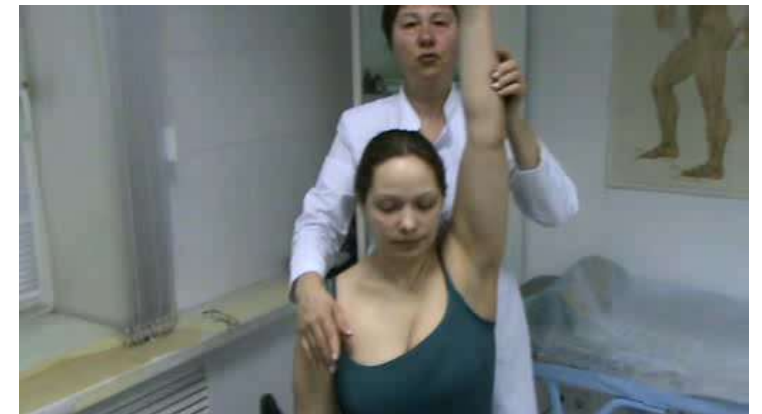
inhibition

normal



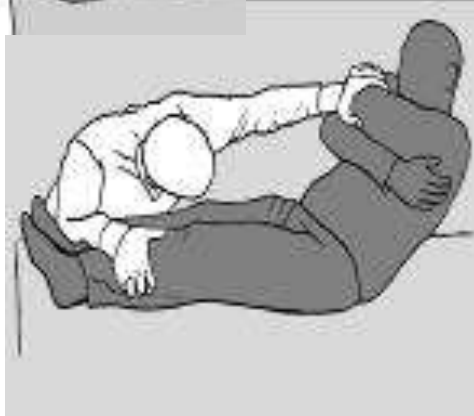
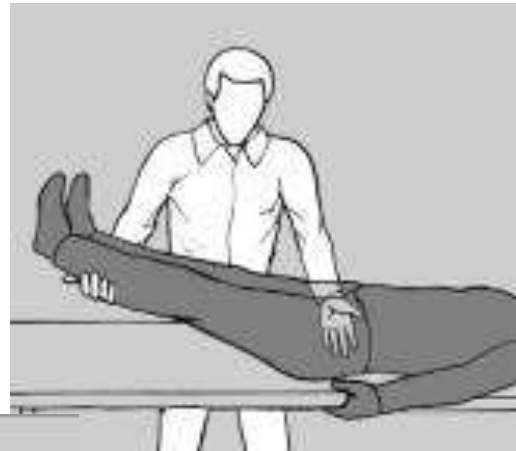
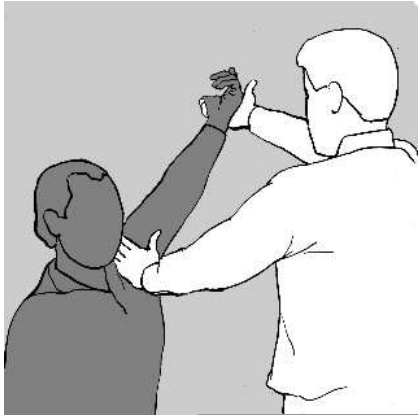
MANUAL MUSCLE TESTING

NORMAL RESPONSE OF A MUSCLE was evaluated as its ability to increase the force of resistance in response to an increasing pressure provided by the doctor's hand. It is noteworthy that such a response of the muscle was evaluated *1,5-2,5 seconds after its isometric contraction*.



What is diagnosed by manual muscle testing?

MMT is a clinical method to evaluate the ability of the nervous system to adapt contractile capacity of an isolated muscle to the increasing stress.





METHODOLOGY RELATED ISSUES

The method of performing Manual Muscle Testing and the system of its evaluation are not clear

1. It is not clear why it is necessary to:
 - perform a preliminary isometric contraction;
 - maintain it for 1,5 – 2 seconds prior to the beginning of short term muscle stretching.
2. It is not clear, why the performance of those stages is not controlled by the central nervous system.





OBJECTIVE

- ▶ Instrumental verification of manual muscle testing, and interpretation of its results based on prof.N. Bernstein's theory.
- ▶ ***Main tasks of this research consists in:***
 - Identifying the mechanism of the neurological response to manual muscle testing (MMT)
 - Algorithm for Using MMT in Neurological Diagnosis of Muscular Pain Syndromes



MATERIALS OF THE RESEARCH

Data regarding 300 patients with muscular pain syndromes of the reflex-based origin provoked by static-dynamic load (change of the body position: sitting, standing, lying, walking).



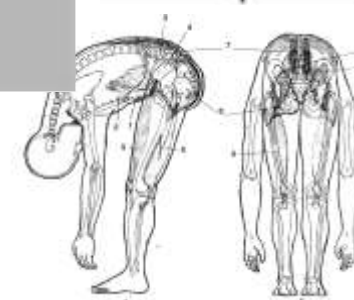
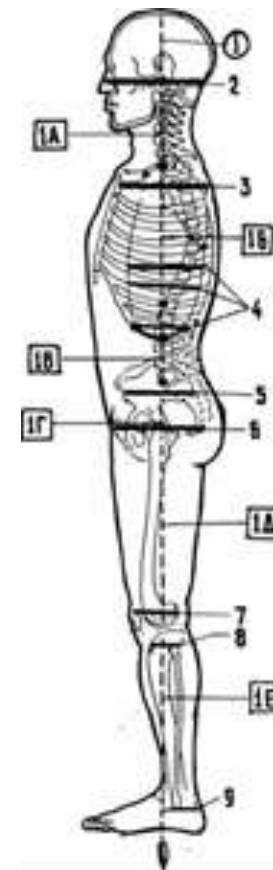
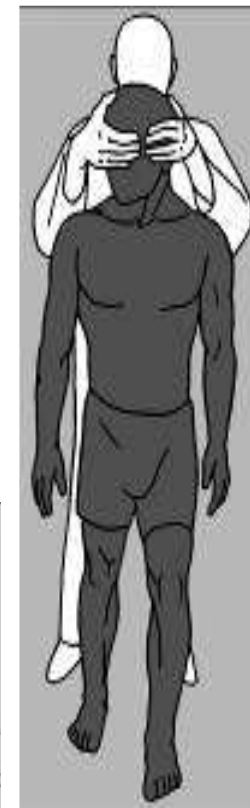


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CLINICAL RESEARCH METHODS

Complaints, comparison of location of pain and its causes

- ▶ Visual diagnosis in static and dynamic
- ▶ MMT under static-dynamic load





INSTRUMENTAL METHODS OF RESEARCH

a) Instrumental analysis of MMT targeting muscles with normal response, and muscles with functional hyporeflexia

- Comparative Computer Dynamometry
- Biodex Medical Systems



b) Response to static load

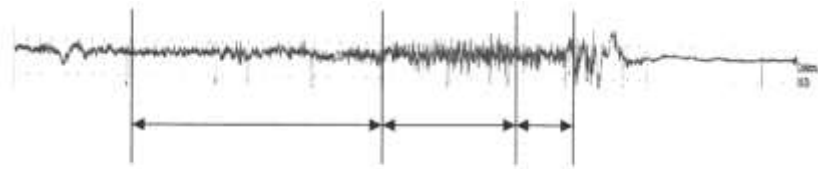
- Computer Topography

c) Response to dynamic load

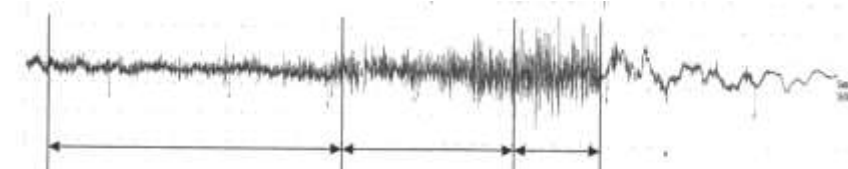
- Superficial EMG of muscles
- Vector EMG



EMG DIAGNOSTIC DURING MANUAL MUSCLE TESTING



Отрезки: 1 2 3
inhibition



Отрезки: 1 2 3
normal



COMPARATIVE COMPUTER DYNAMOMETRY TO EVALUATE MUSCLE STRENGTH DURING MMT

METHODOLOGY.

Computerized cuff was put on the arm of the patient.

In Phase 1, the patient adducted the arm in the glenohumeral joint against the pressure provided by the doctor's hand, while performing isometric contraction of the deltoid muscle.

In Phase 2, after 3 seconds, the patient was asked to increase pressure on the doctor's hand.



At the same time, the computer was registering the force of the two phases of contraction in the form of a curve



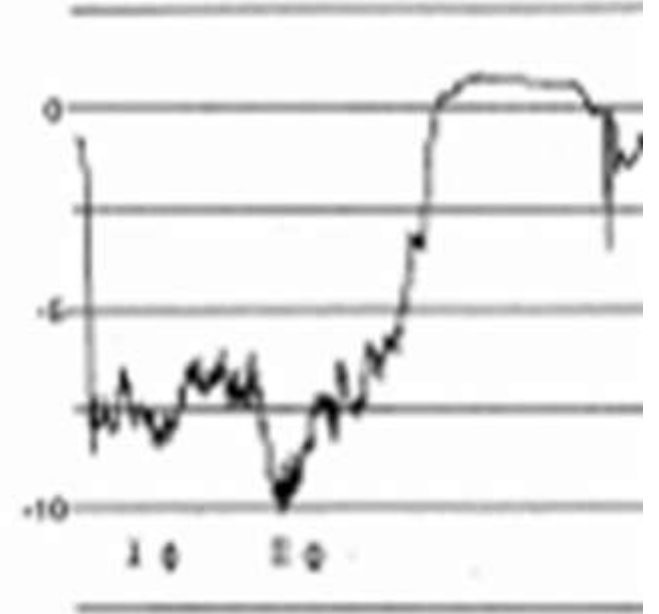
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COMPARATIVE COMPUTER DYNAMOMETRY TO EVALUATE MUSCLE STRENGTH DURING MMT

Normoreactive

In Phase 1, muscle response remained normal irrespective of the force of isometric contraction.

In Phase 2, muscle strength increased by 10% to 15% compared to the original value.





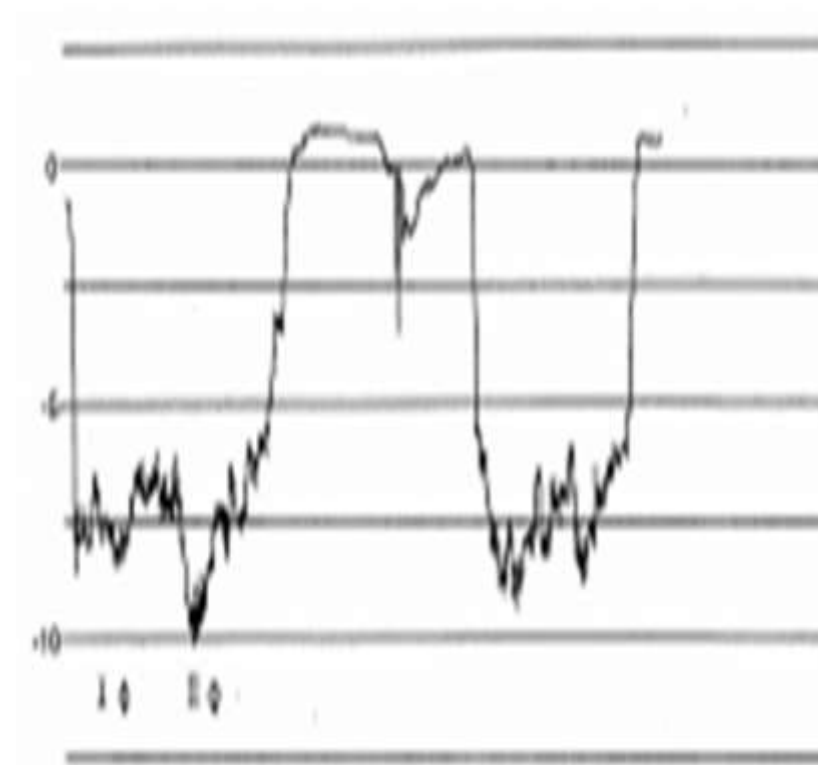
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COMPARATIVE COMPUTER DYNAMOMETRY TO EVALUATE MUSCLE STRENGTH DURING MMT

HYPO-RESPONSE

In Phase 1, muscle response remained normal irrespective of the force of isometric contraction

In Phase 2, with hypo-response, the force of contraction not only **did not increase, as it would be normally expected, but decreased** showing desadaptation of the muscle to isometric load.





BIODEX MEDICAL SYSTEMS TO EVALUATE MUSCLE STRENGTH DURING MMT

METHODOLOGY

Research was done on the rectus femoris muscle.

Patients were asked to make 3 attempts to apply maximum pressure on the stabilizing straps around the thigh, lasting 5 seconds





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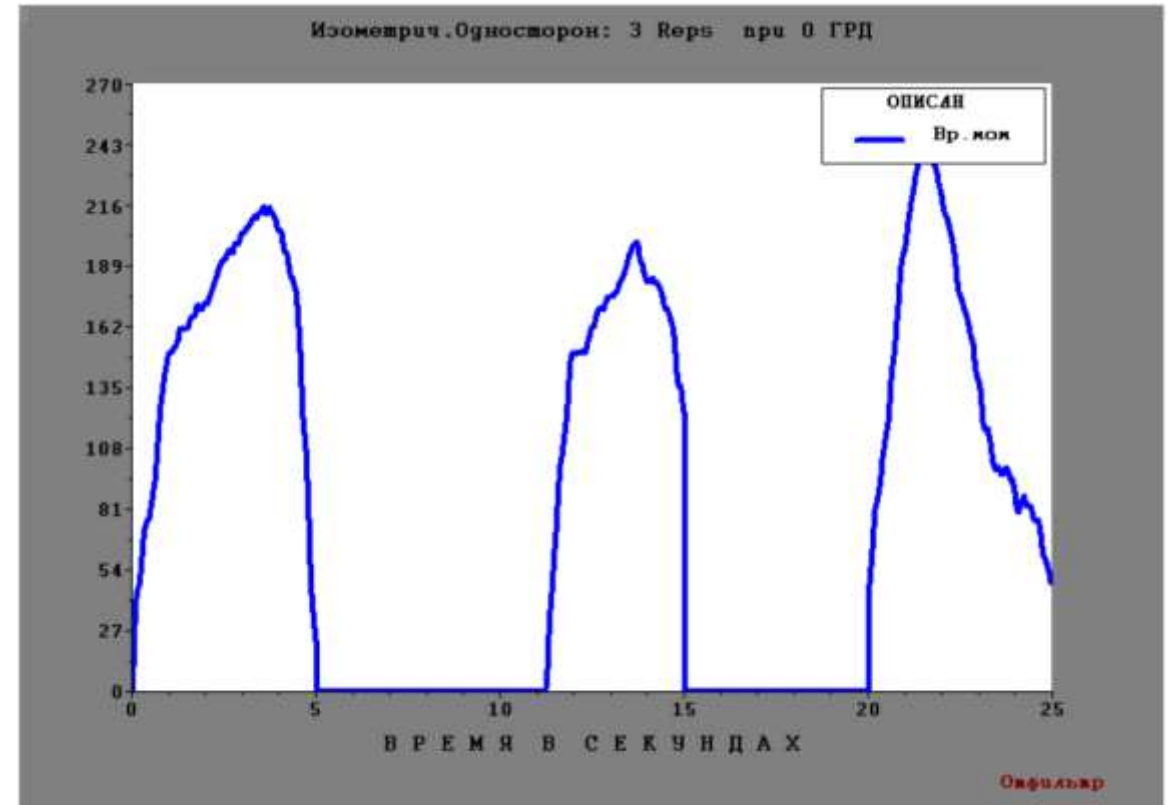
BIODEX MEDICAL SYSTEMS TO EVALUATE MUSCLE STRENGTH DURING MMT,

METHODOLOGY

Normal response.

Maximum strength was registered after the 3rd second of testing.

The graph looked like a curve with a maximum height during the 3rd second of testing.

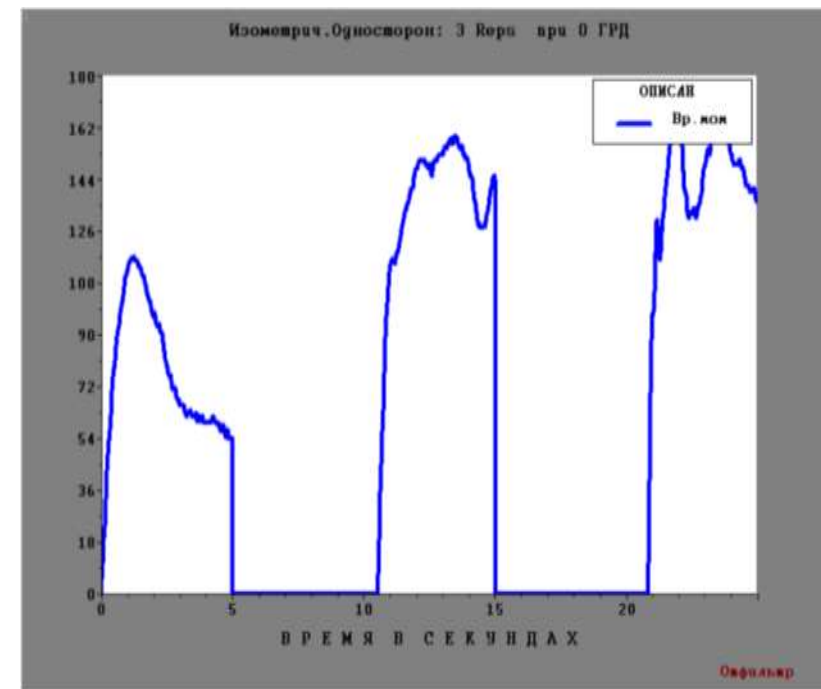




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BIODEX MEDICAL SYSTEMS TO EVALUATE MUSCLE STRENGTH DURING MMT,

Hypo-response. Maximum strength was registered during the first 3 seconds of testing with a **subsequent decrease** in muscle strength. After the 2nd second of muscle contraction, pallidal tremor occurred. That being said, the overall muscle strength decreased by 3,9 % to 0,15 %.



CONCLUSION

According to Professor N.A. Bernstein, during **MANUAL MUSCLE TESTING**, two distinct phases of muscle contraction are identified that:

- A) Behave differently with respect to isometric load which makes it possible to confirm that there are two phases of contraction.
- B) Have different origins.
- C) React differently to gravitational load.
- D) Owing to the above, require different methods for their restoration.

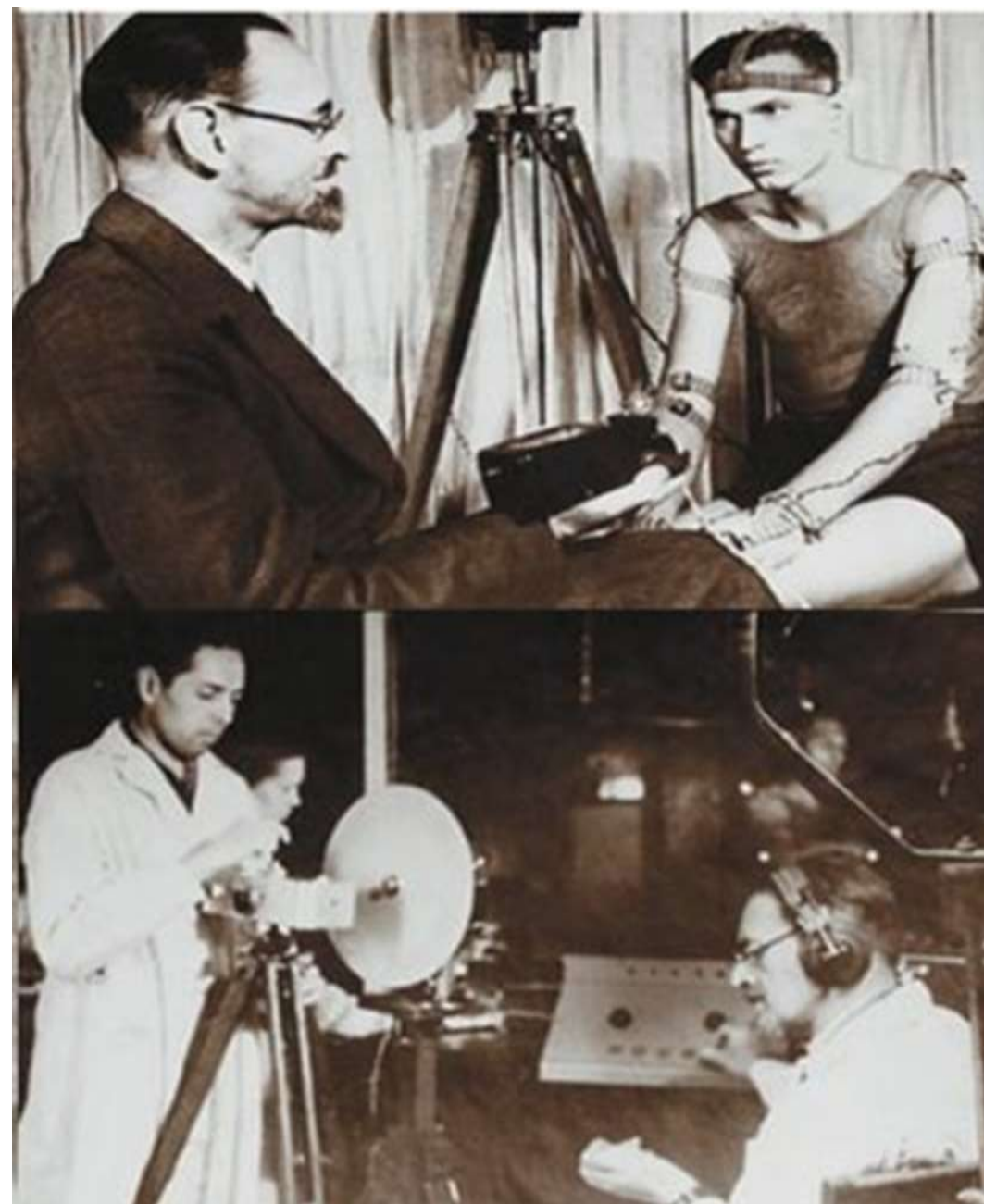




VIDEO ANALYSIS OF REGISTERING MOVEMENT (PROFESSOR N.A. BERNSTEIN)

Based on the results of
photogrammetric registering,
there are two phases of movement:

1. Phasic contraction
2. Tonic contraction



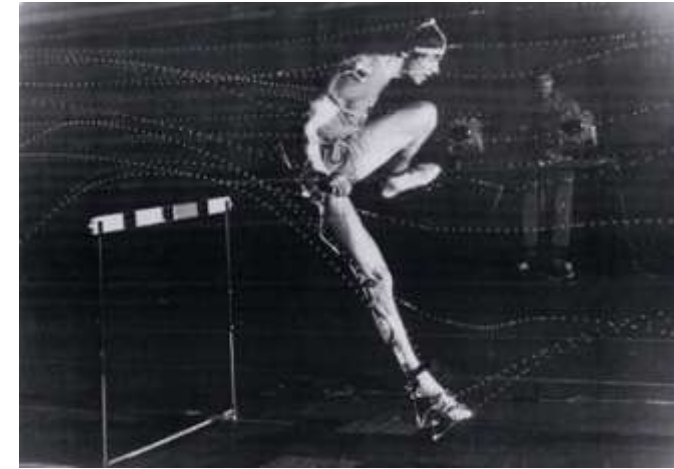


PHASE 1 – PHASIC CONTRACTION

Change of length with maintaining tonus is characterized by the following features:

- 1) It is meant for fast, voluntary, short-term movements during **concentric and eccentric** muscle contraction.
- 2) It is regulated by cortical structures, voluntary correction is possible.
- 3) When an afferent signal occurs, this type of contraction is the first to respond and to be involved in maintaining contraction.
- 4) Information is transmitted mostly by electrical impulse.
- 5) It shows quick fatigue.

Noninformative for MMT.



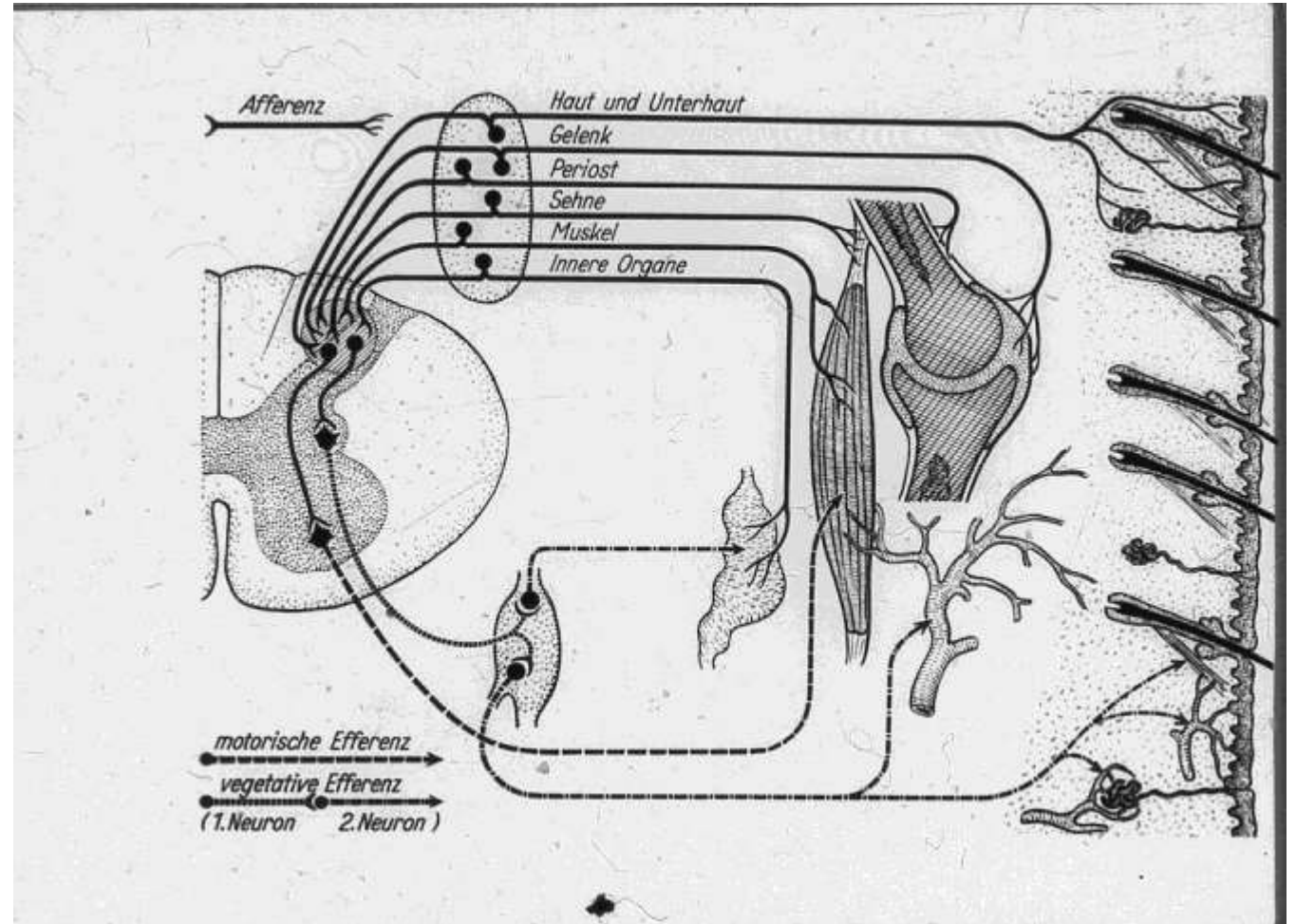


PHASE 2. TONIC CONTRACTION

- 1) It is meant for long term maintenance of constant length of a muscle (isometric postural contraction).
- 2) Regulation at the level of thalamo-pallidary system.
- 3) Voluntary change in the strength of contraction is impossible. Strength of contraction changes only when afferentation is distorted.
- 4) When an afferent signal occurs, this type of contraction is the second to respond, and gets involved in movement **3 seconds after isometric contraction occurs.**

PHASE 2 – TONIC CONTRACTION

The same undifferentiated reaction of the change in muscle tone to irritation of inter-proprio – exteroceptors (skin, muscles, internal organs, vessels and muscles).





PHASE 2. TONIC CONTRACTION

- 5) Transmission of the impulse is mostly chemical.
- 6) Fatigue occurs slowly.
- 7) During testing, it is evaluated as an additional increase in the strength of isometric contraction that has already **lasted for 1.5-2.5 seconds** (an additional increase in the strength of resistance against the doctor's hand on his/her command).

Description of the conditions for stage 2 confirms that MMT registers functional hypotonia



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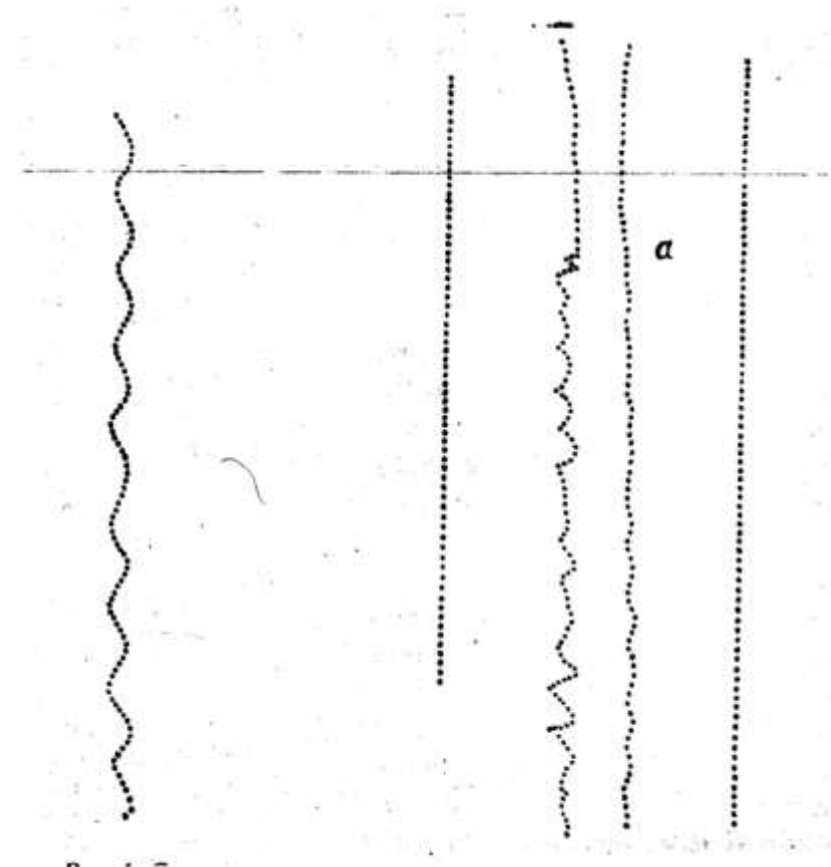


PHASE 2. TONIC CONTRACTION

N.A. Bernstein

Visual diagnosis. Displacement of the gravity center.

Registration of pallidal tremor during isometric muscle contraction in statics



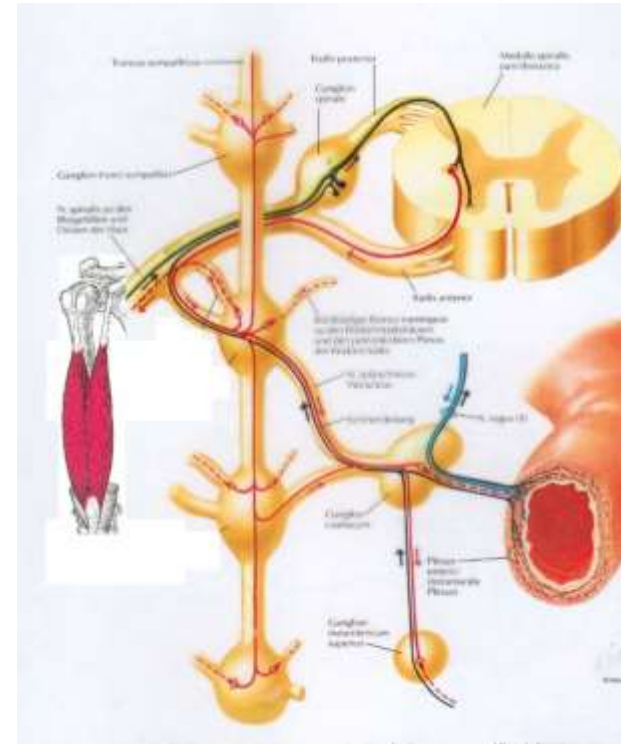


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VISCERO-MOTOR AND MOTOR-VISCERAL REFLEXES



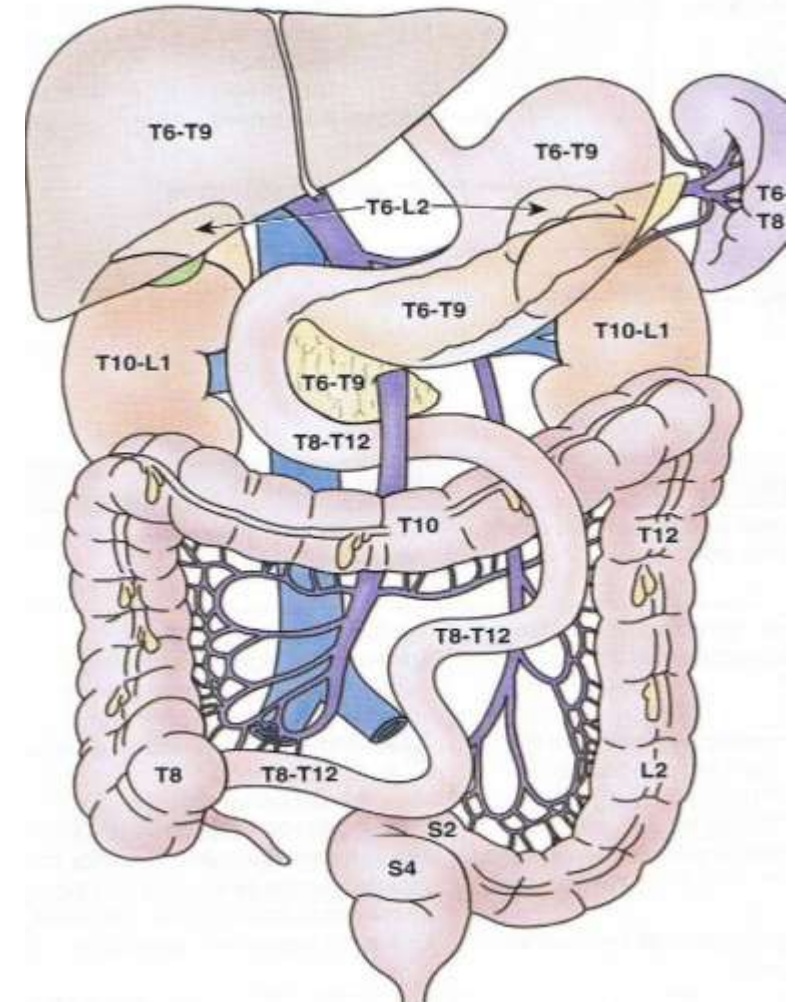
Experiments on animals



Prof. M.R. Mogendovich
(1900 - 1979)

SHARED LEVELS OF VISCERAL AND SOMATIC INNERVATION

Organ	Level	Muscle
Duodenum, small intestine	Th 8-12	Abdominal Muscles
Ascending, transverse and descending colon	Th10-12	m. Quadratus lumborum
Sigmoid	L2-L4	TFm. L
Rectum	S1-3	mm. Biceps femoris. M. Soleus M. gastrocnemius
Kidneys	Th 10-L1	m. Ilio-psoas
Reproductive system	L5-S1	m. piriformis, gluteal muscles, adductors





CONCLUSION

1. Performance of manual muscle testing and analysis of its results are consistent with the second phase of movement, namely – the phase of tonic contraction
2. During manual muscle testing functional hypotonia, hyporeflexia are registered.



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ALGORITHM FOR USING MMT IN NEUROLOGICAL DIAGNOSIS OF MUSCULAR PAIN SYNDROMES

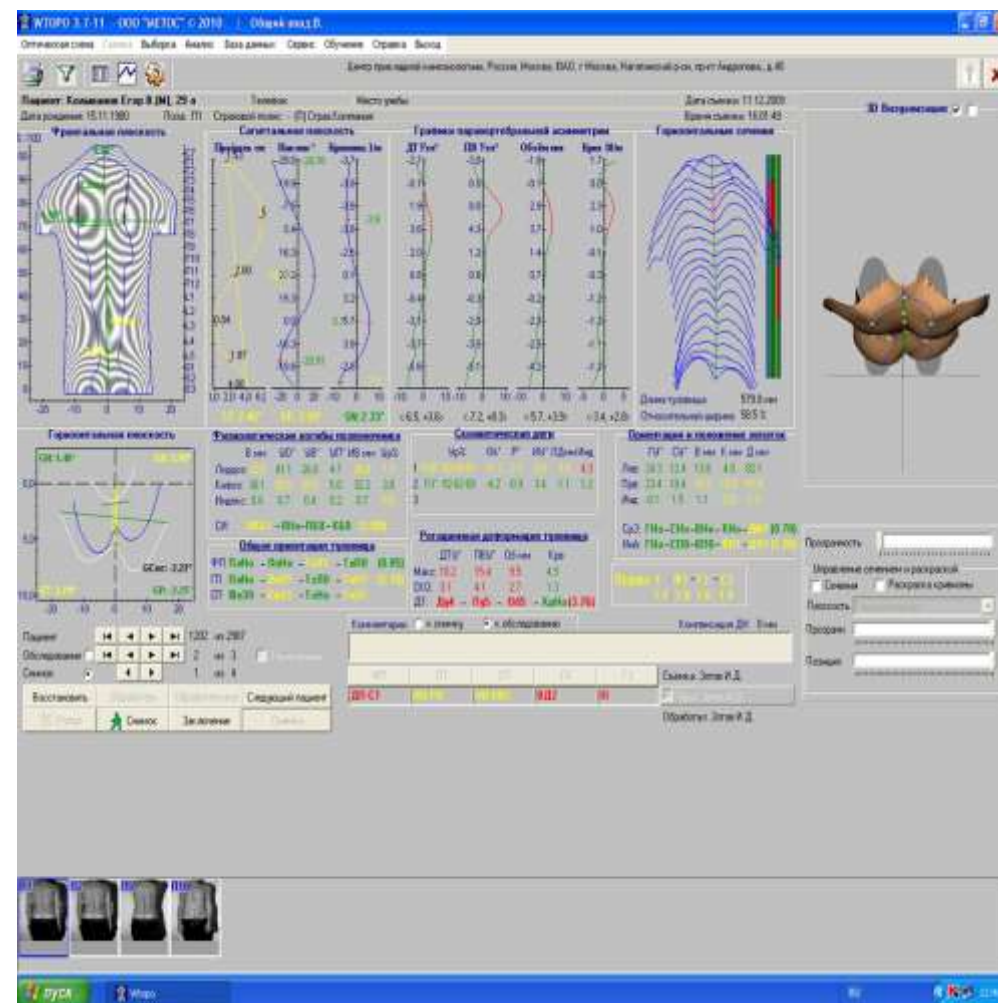
REACTION OF A FUNCTIONALLY HYPOTONIC MUSCLE TO STATIC LOAD

120 patients with muscular pain syndromes provoked by static load (change of the body position - standing, sitting, lying) were involved in this research



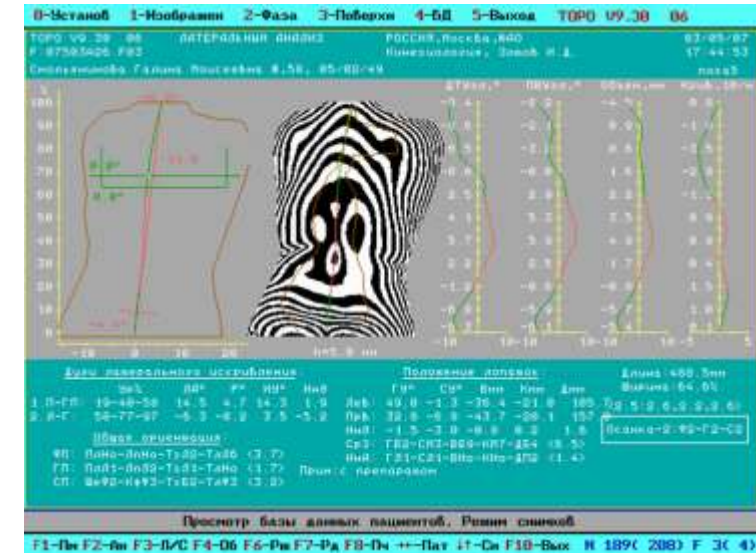
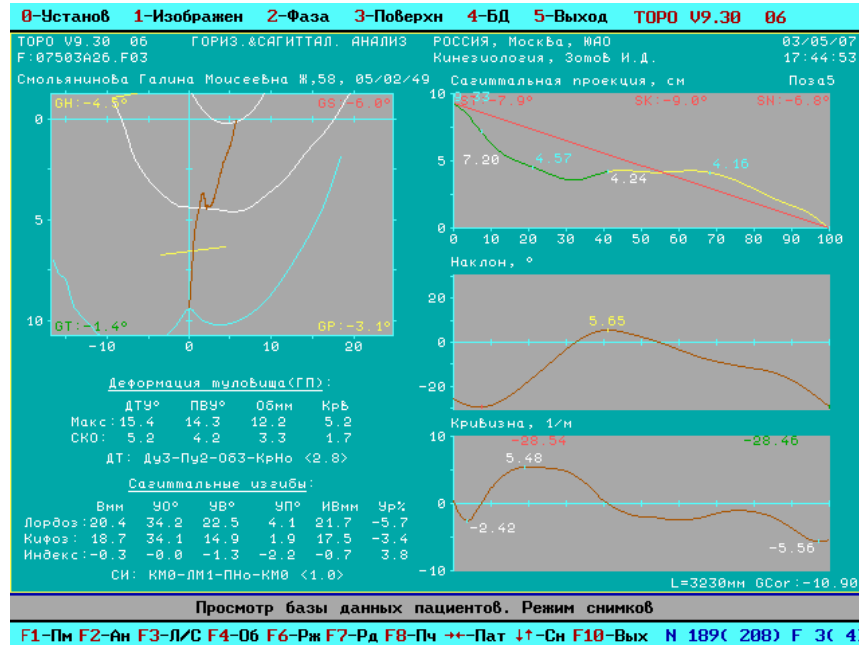
CLINICO-INSTRUMENTAL METHODS OF RESEARCH

1. Computer topography
2. Cardiointervalography
3. Visual diagnosis





COMPUTER TOPOGRAPHY



Methodology. Muscle stretch with the symptoms of functional muscle hypotonia was registered in standing position under gravitational isometric load



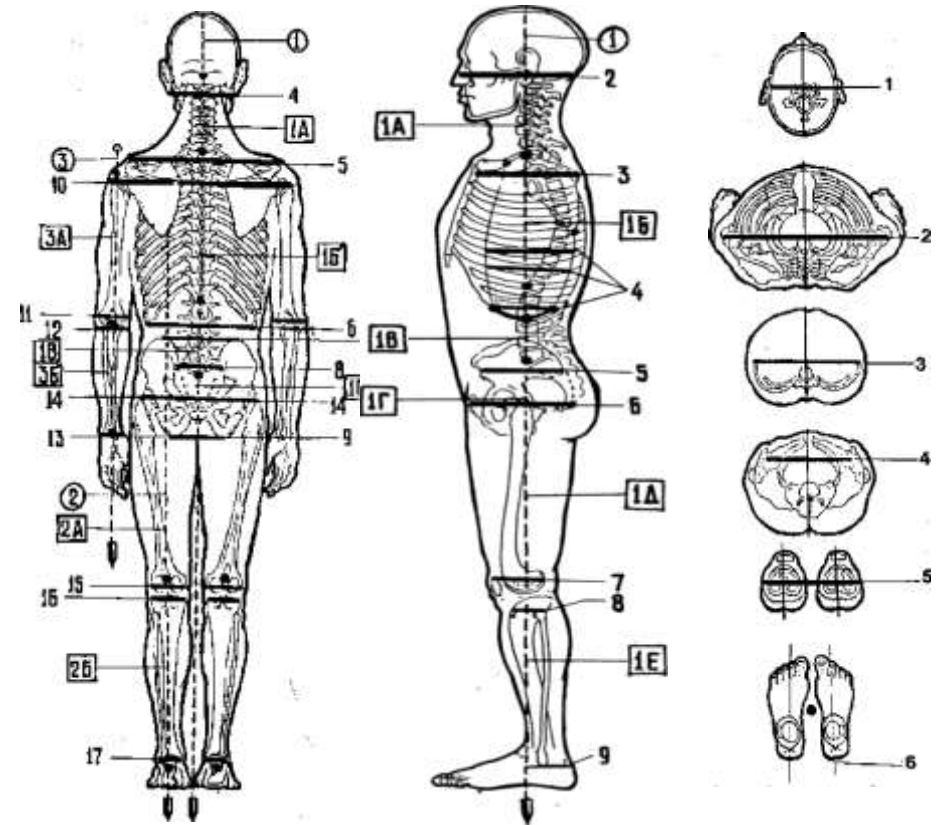
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VISUAL DIAGNOSIS

Methodology. Borders of the regions were compared to determine if they were parallel. In addition, deviation of the projection of the plumb line in three planes was checked.

Criteria for Optimal Statics

1. Passage of the common gravity center through transitional areas of the spine and center of the feet.
2. Parallel horizontal lines passing through the borders of the regions.





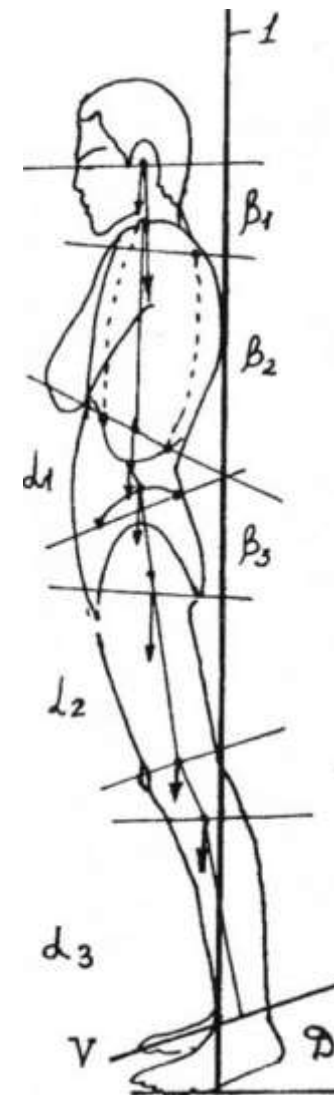
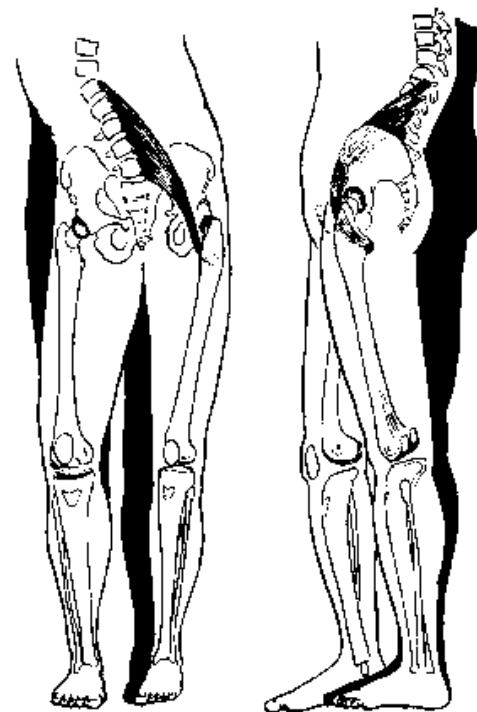
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VISUAL DIAGNOSIS

CRITERIA FOR NONOPTIMAL STATICS

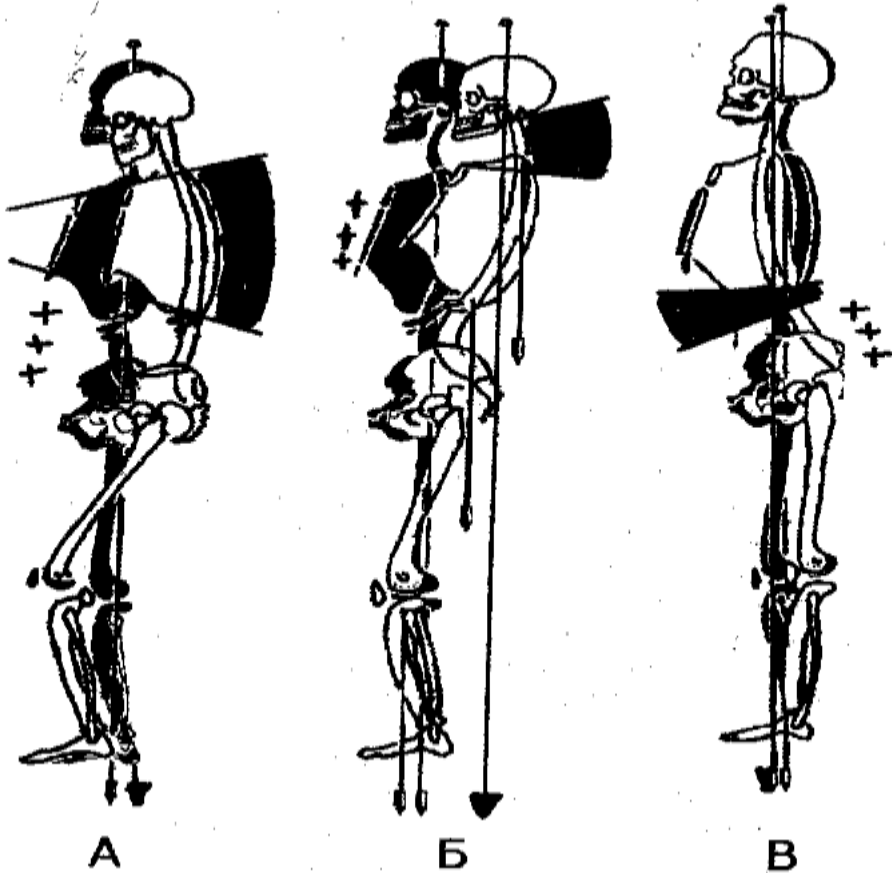
Muscles with Functional Muscle Hypotonia **stretch moving away** from their insertions.

It leads to the **displacement of the gravity center** and prevents the body from falling down



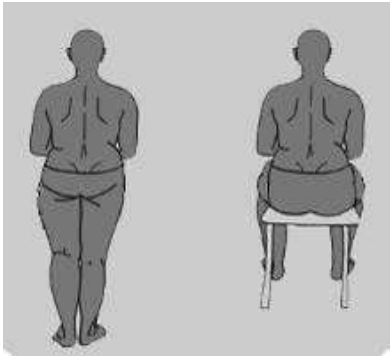


CONCLUSION



Location of **muscular pain** does not coincide with the location of its origin. Instead, it is located in the areas of **shortened antagonistic muscles** or posturally overloaded muscles (marked by +).

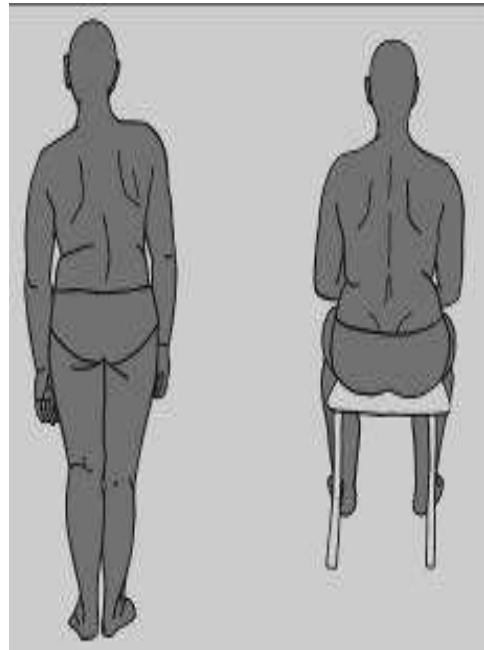
Pain is only a marker of static overload, and it disappears spontaneously after the treatment of its cause is performed



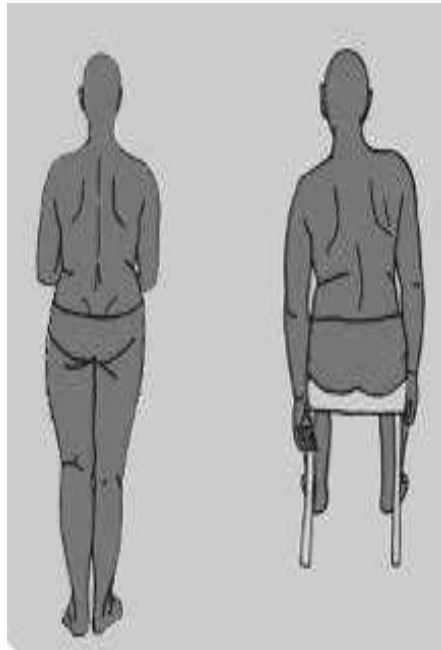
normal

COMPARISON OF THE LOCATION OF PAIN AND ITS CAUSE

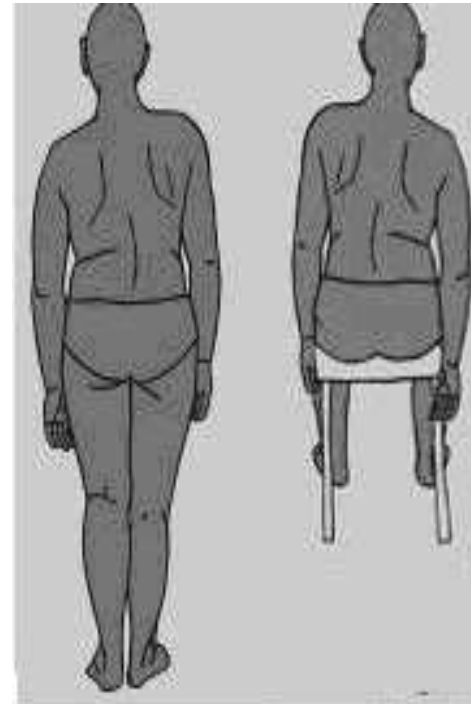
Evaluation criteria – asymmetry of the shoulder girdle under different load



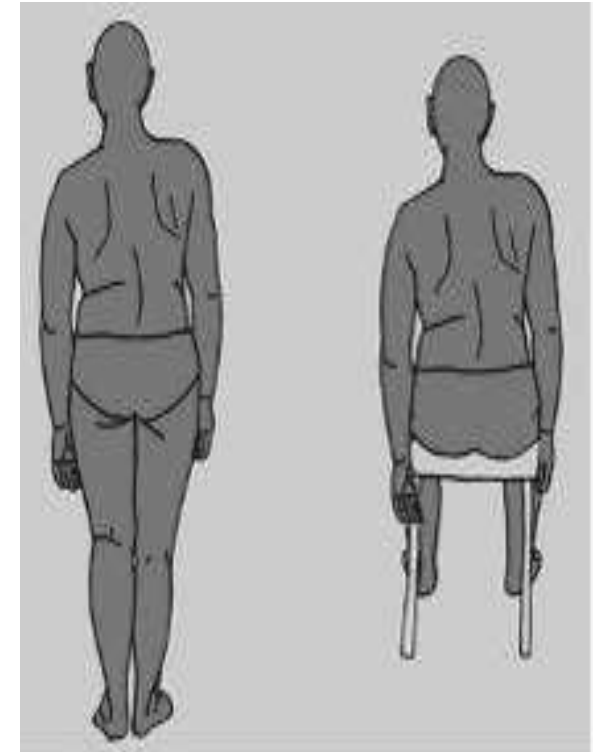
**Cause –
Pathobiomechanics
of the feet (45 %)**



**Cause –
Pathobiomechanics
of the pelvis (25 %)**



**Cause –
Pathobiomechanics of
the feet and pelvis (10%)**



**The cause is not in the spine
(20%)**

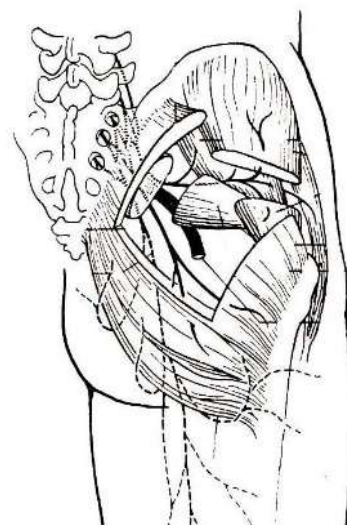
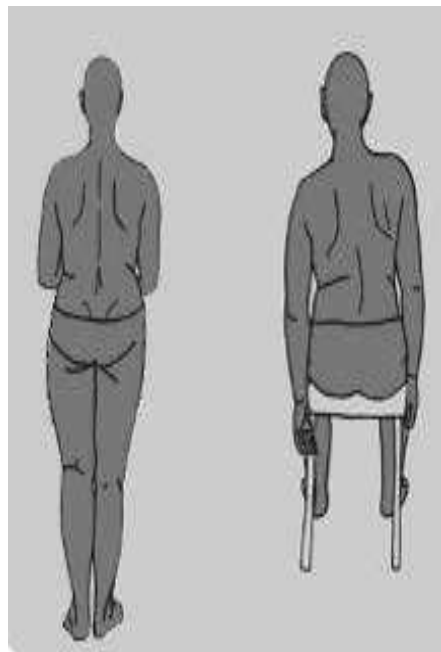


CONCLUSION

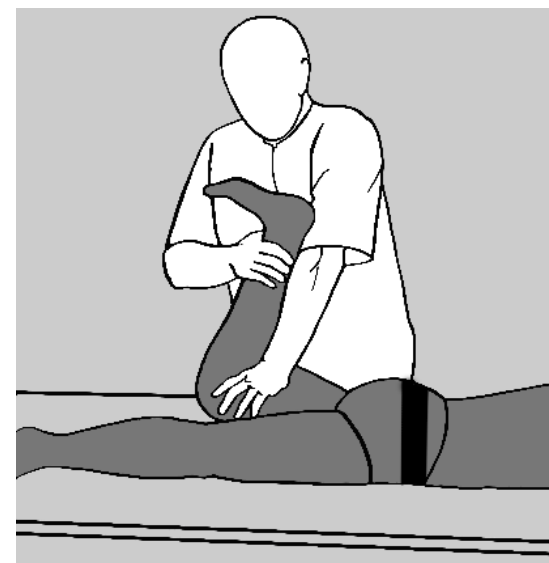
Location of muscular pain does not coincide with the location of its origin. Instead, it is located in the areas of shortened antagonistic muscles or posturally overloaded muscles. Pain is only a marker of static overload, and it disappears spontaneously after the treatment of its cause is performed.



Cause -
Pathobiomechanics of the pelvis



correction

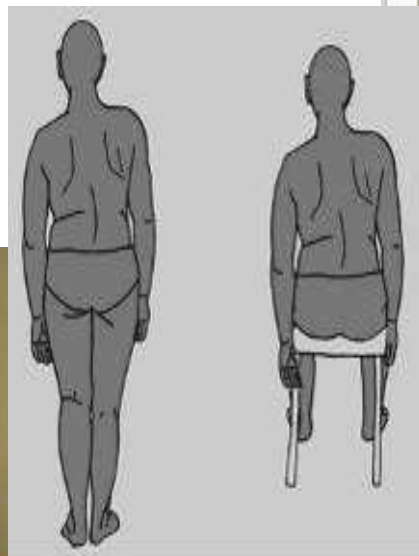
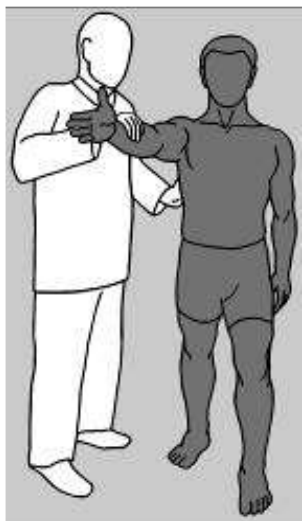




CARDIOINTERVALOGRAPHY!

Evaluation of the Vegetative Nervous System

Absence of reaction of the muscular imbalance in terms of tone and strength to static or dynamic load was interpreted as significant disturbance of the vegetative nervous system.



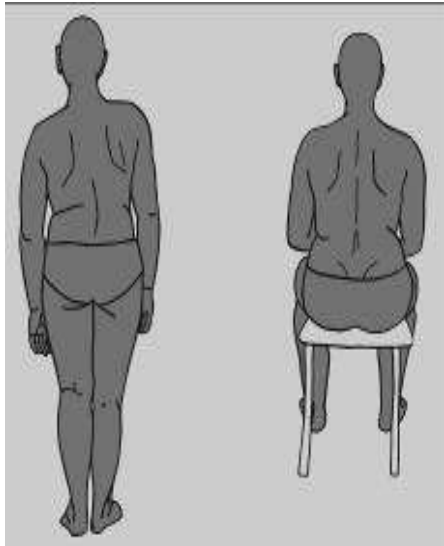


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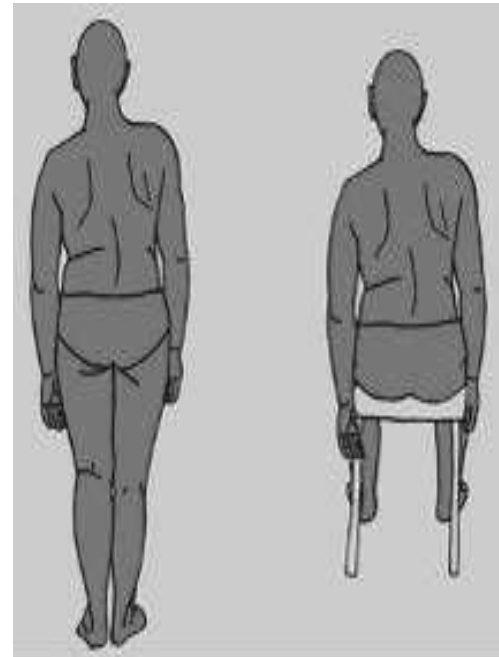
CONCLUSION

Change in pain intensity when static or dynamic load is changed, indicates disturbance of the somatic nervous system which is an indicator for manual therapy, or chiropractic care.

Absence of change in pain intensity when static or dynamic load is changed, indicates disturbance of the vegetative nervous system which is an indicator for visceral therapy.



Cause - feet
Treatment - feet



**Cause – disturbance
autonomic nervous system**
Treatment – visceral MT

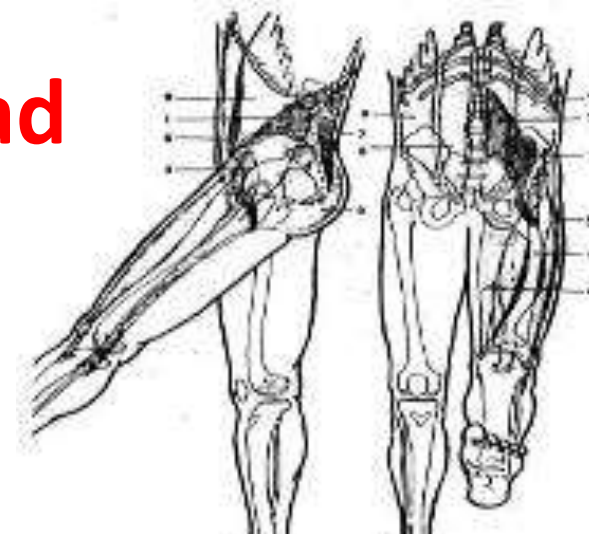


Algorithm for Using MMT for Neurological Diagnosis of Muscular Pain Syndromes

- Analysis of the reaction of muscles with functional hypotonia to static load.
- 120 patients with muscular pain syndromes of the reflex based origin, provoked by dynamic load (walking), were involved in this research.



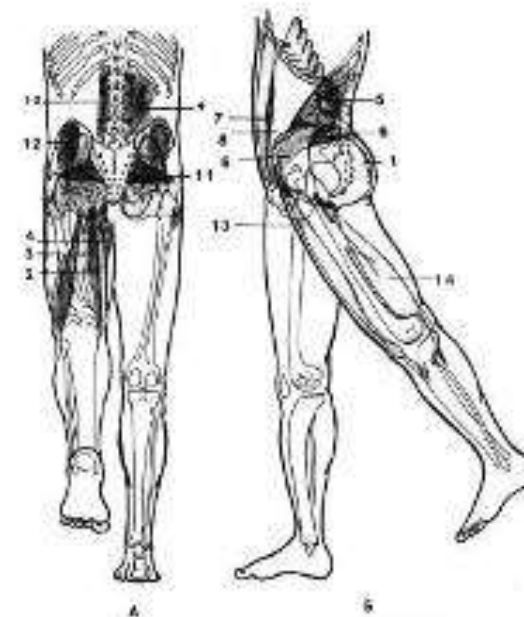
Body Reaction to Dynamic Load



Visual Diagnosis of Nonoptimal Dynamics

A) Visual diagnosis of sequential and parallel activation of several motor patterns;

B) Visual diagnosis of the disturbance of correct performance of an individual motor pattern (same direction of movement, absence of synergies in other regions).

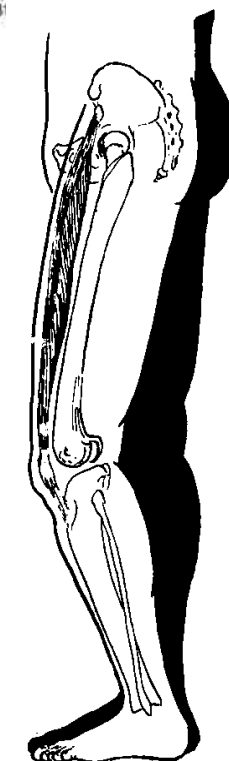
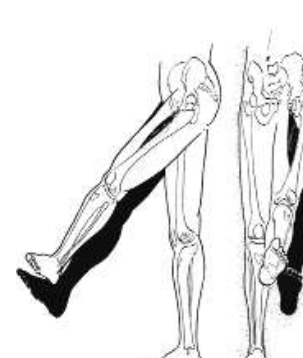
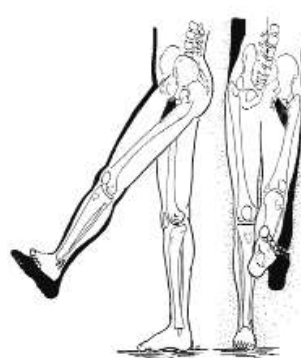
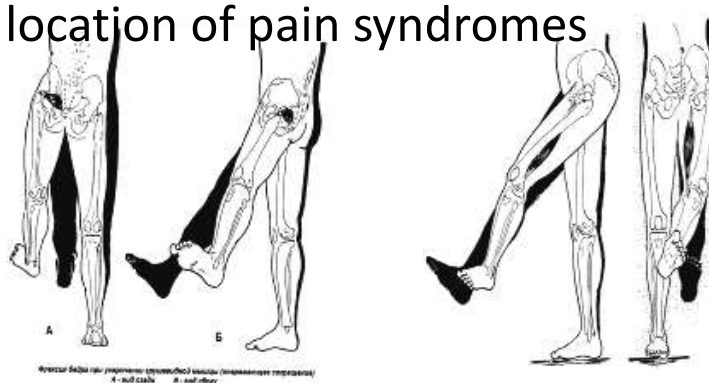
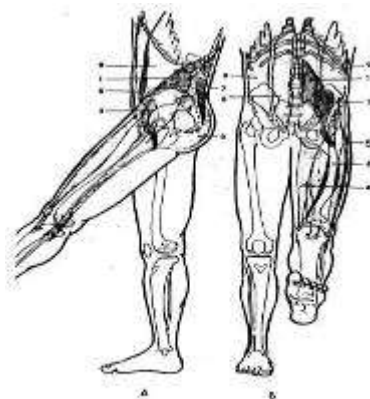
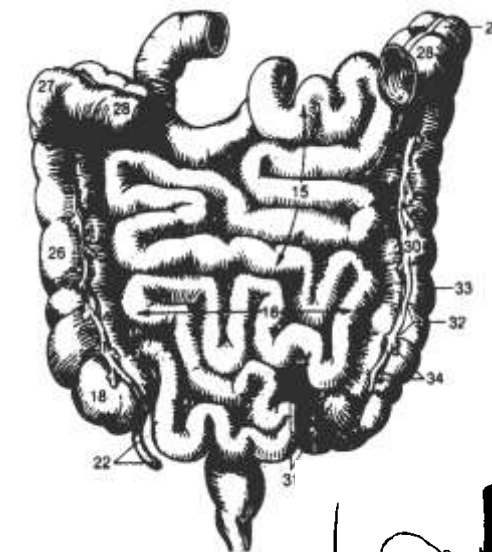




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PATHOLOGICAL ACTIVITY OF VISCERO-MOTOR REFLEXES IN DYSFUNCTION OF REPRODUCTIVE ORGANS AND GLUTEUS MAXIMUS

Hypoactivation of the rectus femoris muscle, compensatory anticipatory recruitment of other muscle groups determine the location of pain syndromes

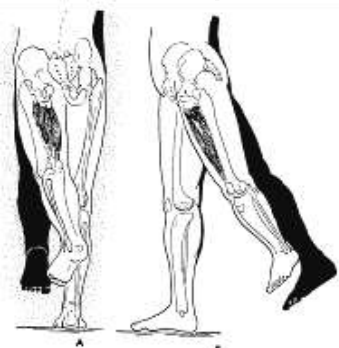
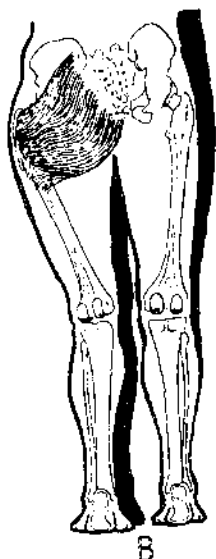
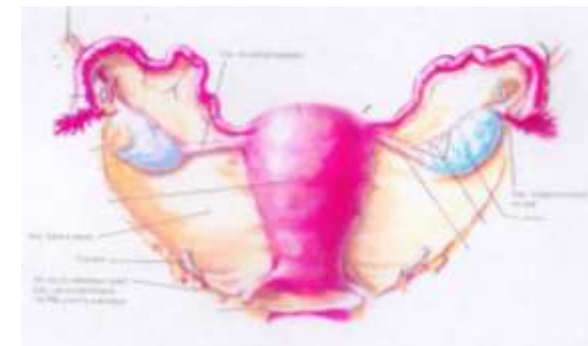




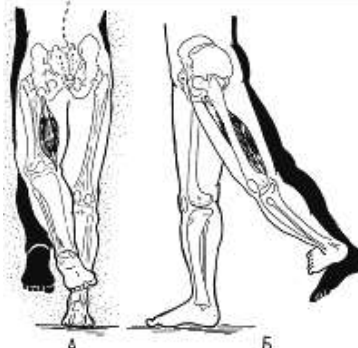
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PATHOLOGICAL ACTIVITY OF VISCERO-MOTOR REFLEXES IN DYSFUNCTION OF REPRODUCTIVE ORGANS AND GLUTEUS MAXIMUS

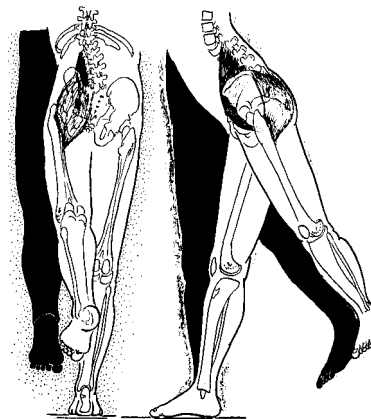
Hypoactivation of the rectus femoris muscle, compensatory anticipatory recruitment of other muscle groups determine the location of pain syndromes.



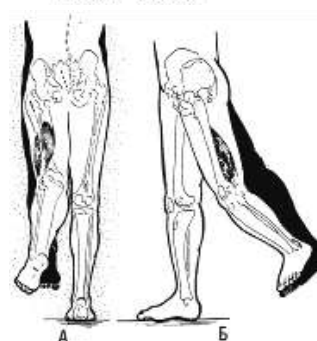
Экстензия бедра при укорочении боковой поясничной мышцы бедра (отражающее состояние)
А - вид сверху Б - вид сбоку



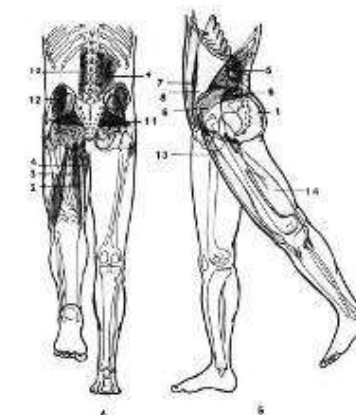
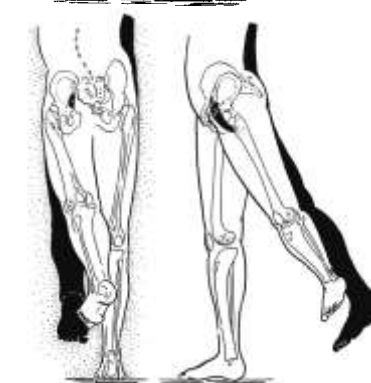
Экстензия бедра у газонщика с укорочением латеральной и подвздошно-брюшной мышц
А - вид сверху Б - вид сбоку



Экстензия бедра при укорочении медиальной поясничной мышцы (отражающее состояние)
А - вид сверху Б - вид сбоку



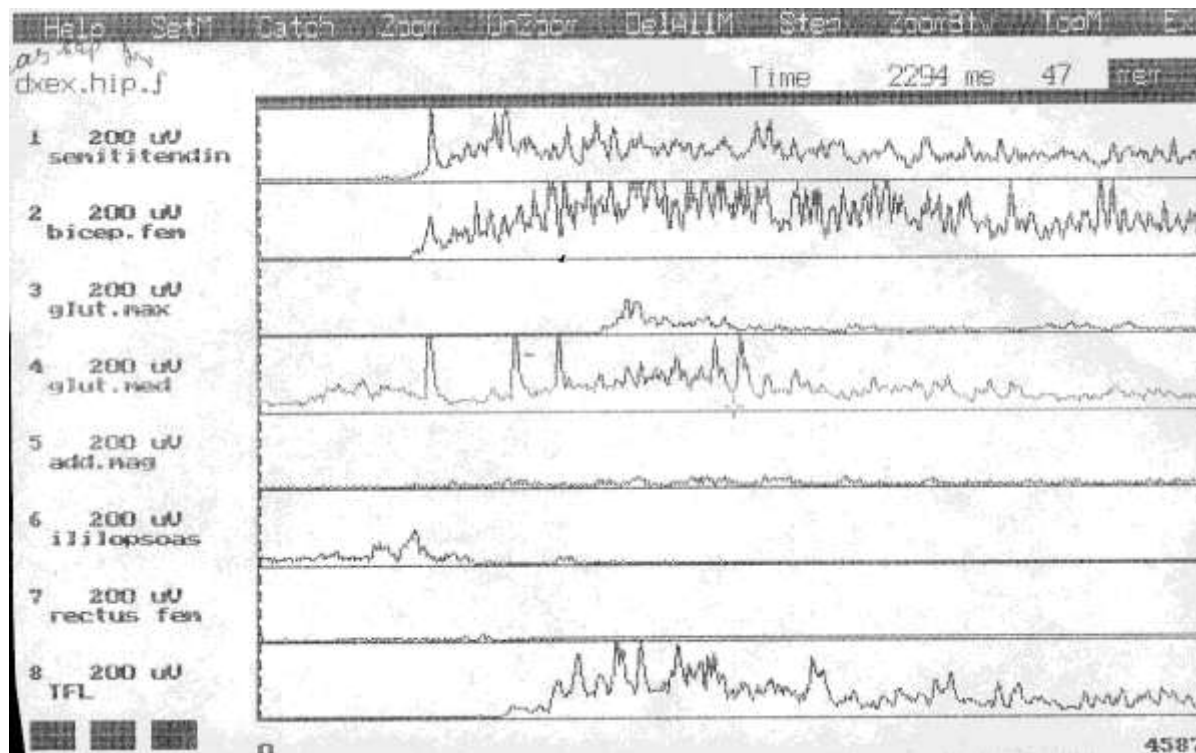
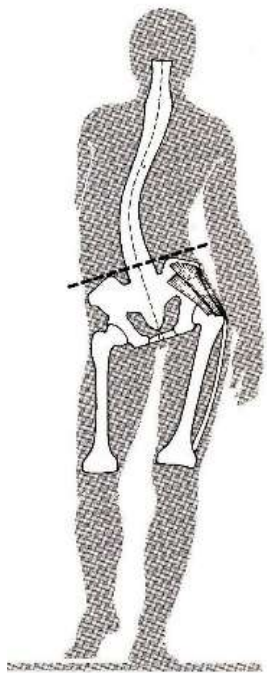
Экстензия бедра у падальщика с укорочением боковой мышцы бедра (отражающее состояние)
А - вид сверху Б - вид сбоку





Electromyographic Diagnosis

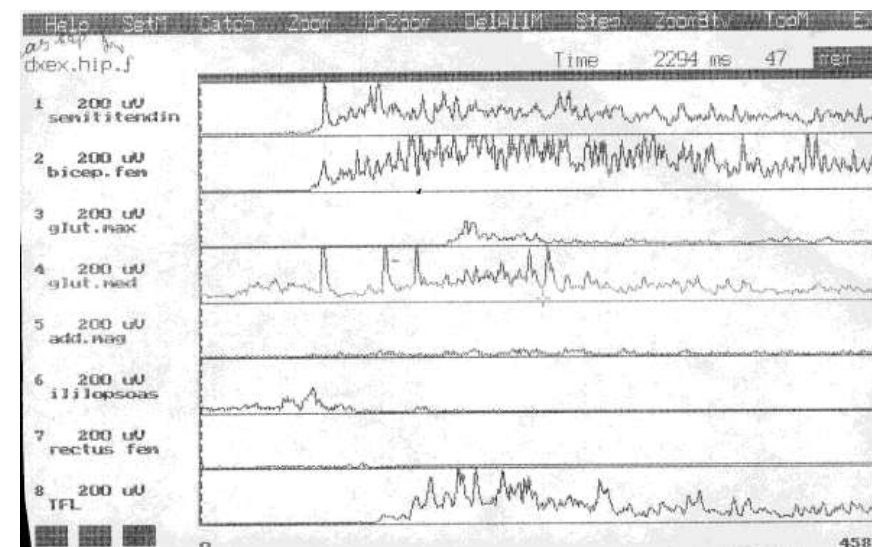
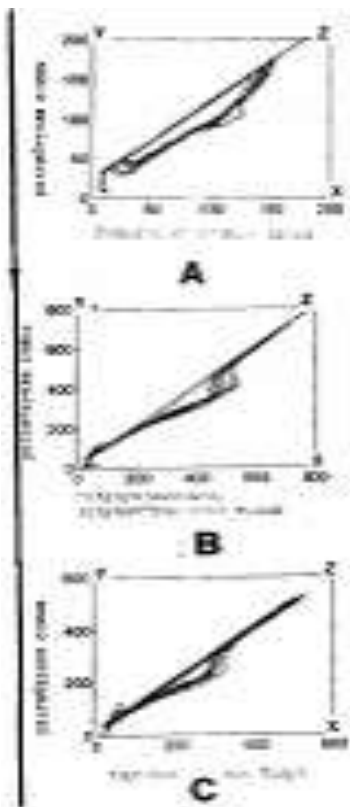
Decrease in irritability of an agonistic muscle with certain movements and compensatory overload of other muscles.





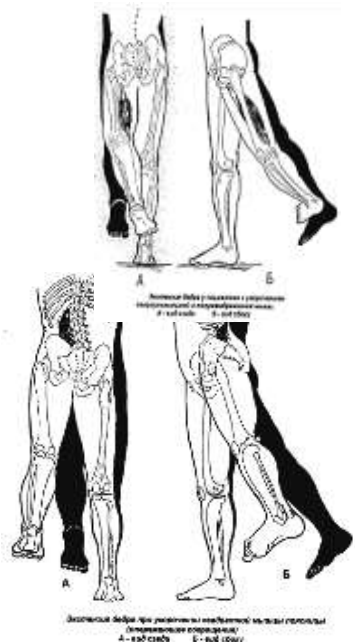
Vector Electromyogram

- Analysis was done of the bioelectrical tone (circumflex EMG) activity of hip extensors during multiple performance of walking pattern.
- Circumflex electromyograms were positioned along the X/Y Axis system. On the X -Axis, circumflex EMG was positioned around gluteus maximus – an agonistic muscle (A), and synergistic hip extensors (B, C).
- On the Y-Axis, circumflex EMG was positioned around the fixator of the quadratus lumborum muscle (A, B, C).
- On the Z-Axis, the line that was the result of their mutual influence was positioned.

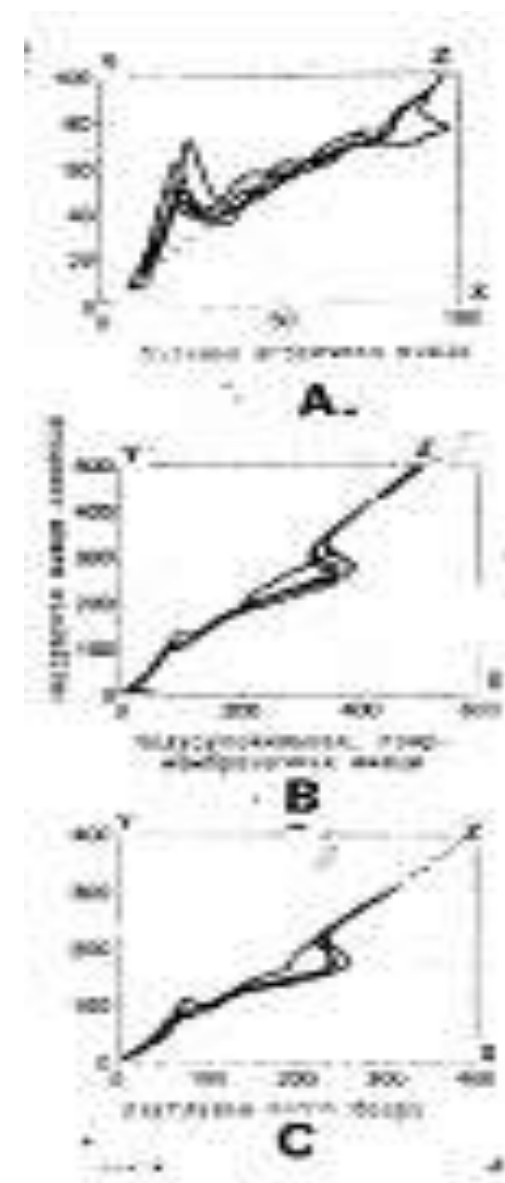


Evaluation of Vector Electromyograms

Results of the evaluation of vector EMG with hypoactivity of the agonistic muscle - gluteus maximus, and compensatory hyperactivity of another muscle group - quadratus lumborum.



Maintenance of the prevailing activity of hip extensors – biceps, the semitendinosus muscle relative to the quadratum lumborum muscle.





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CONCLUSION

Hyperirritability of the fixator of the quadratus lumborum muscle was the body's reaction to hypotonia of the agonistic muscle – gluteus maximus. It does not require correction being a secondary reaction that disappears when the normal tone of the muscle is restored, as is the case with other muscles.



CONCLUSION

Analysis of the sequence of recruitment in movement of a muscle with signs of functional hypoactivity revealed its delayed activation, which is an indication of its hypo-irritability.

Location of muscular pain provoked by movement does not coincide with the location of its occurrence. It is located in those areas where there dynamically overloaded muscles.

Pain is nothing more than a marker of dynamic overload, and it disappears spontaneously after correction of the cause is done.



CONCLUSIONS

1. MMT evaluates the tonic component of movement. When it is affected, functional hypotonia, hypoesthesia, and hyporeflexia are diagnosed.
2. Functionally hypotonic muscle reacts to static load by stretch. It leads to compensatory overload of antagonistic muscles causing their shortening and pain.
3. Functionally hypotonic muscle reacts to dynamic load by muscular hypo irritability. It leads to compensatory hyperirritability of other causing their shortening and pain.
4. Absence of pain syndrome reaction to static-dynamic load shows that vegetative nervous system may be affected, and it requires correction for its recovery.

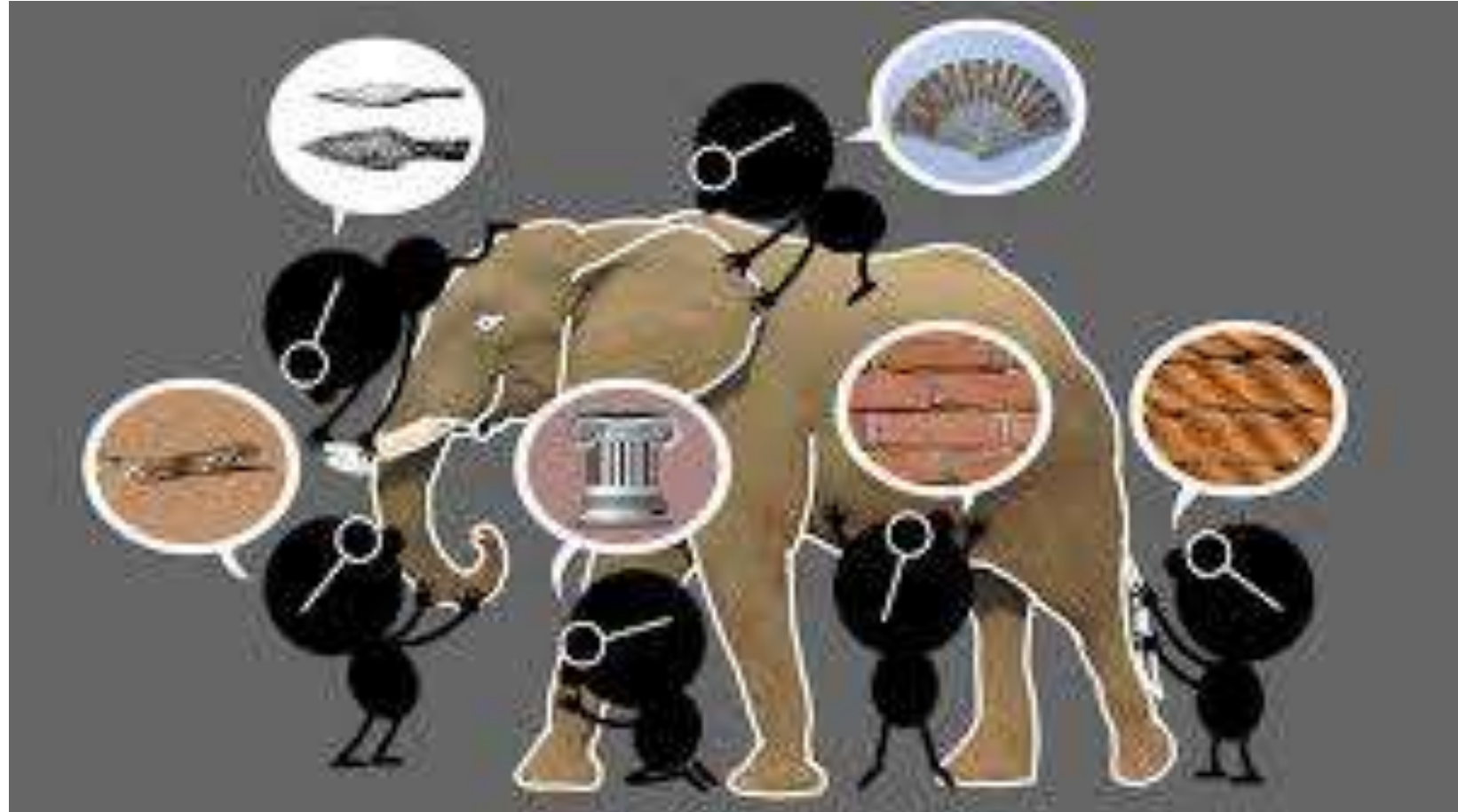


SUMMARY

1. This research enabled us to develop a new approach to treating patients with muscular pain syndromes of reflex-based origin.
2. MMT makes it possible to detect hidden compression syndromes, and to provide therapy based on pathogenetic substantiation.
3. Future research could involve the study of adaptation possibilities of the nervous system when exposed to the environment.



Thank you for attention



What is manual muscle testing ?



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CAN BE FOUND ON THE WEBSITE**

**THANK YOU
FOR YOUR ATTENTION!**

