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Principles of Clinical Application in the Analytical and Systemic Biomechanical Model

1. Introduction: from physical principle to therapeutic application

This appendix provides general guidance on how to apply the physical principles presented in the text to the treatment of muscular shortening.
These are not rigid protocols, but guiding principles that each professional may adapt according to their own training and experience.
As shown in the previous chapters, the therapeutic goal is to reduce Resistant Force in order to increase available Working Force.
This is achieved by acting on both components of the muscle fibre: the contractile component and the connective tissue component.

1.1 The limits of spontaneous movement

No spontaneous human movement is capable of re-lengthening a shortened muscular system.
Spontaneous movements always respect the limits imposed by existing shortenings, and the body cannot voluntarily overcome its own structural restrictions.
Recovery of length requires specific guided therapeutic exercises that bring the tissue beyond the limits that the nervous system has accepted as normal.
Shortening affects both the contractile portion, in which basal tone essentially increases, and the connective tissue portion, in which true residual shortenings accumulate.
These are two different portions requiring two different approaches.
This does not mean that movement has no functional or preventive value, but that it is not sufficient on its own to modify structural shortenings that have already become stabilized.

2. Therapeutic action on the contractile and connective tissue portions of the muscle fibre

2.1 Contractile portion of the muscle fibre

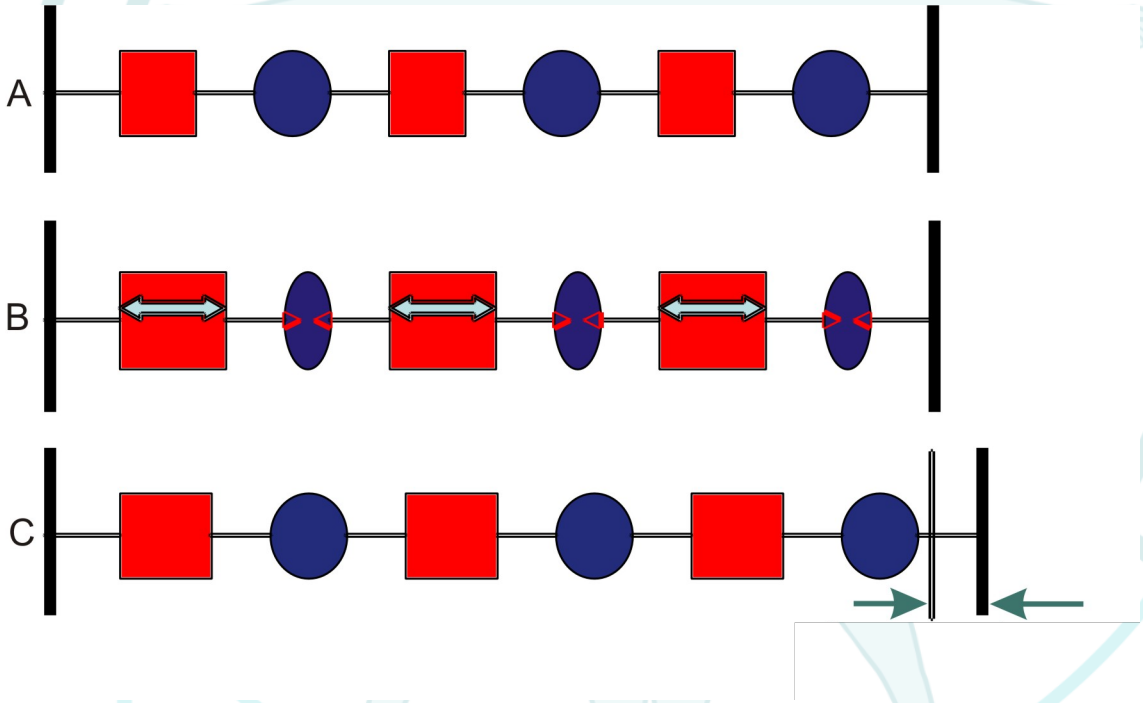
This is the simpler portion to treat because it is responsive to any muscle relaxation technique.
The limitation of these techniques is that they are ineffective on the connective tissue portions.
A bridge between the two portions is represented by manual techniques directed toward the fascia.

2.2 Connective tissue portion of the muscle fibre

This is the more complex portion because, unlike the contractile portion, on which one may also act independently, spontaneous movements are ineffective.
Action on the connective tissue portion requires the intervention of the therapist, who will act passively through deep massage along the direction of the muscle fibres or, more effectively, through active work performed by the patient using isometric contractions at the point of maximum physiological or relative lengthening of the muscle fibre.

2.3 Effects of isometric contraction

Isometric contraction produces lengthening of the connective tissue portion only if it is performed at the point of maximum lengthening of the fibre.
Maximum lengthening will be relative to the maximum passive extensibility of the treated muscle and may not correspond to its maximum physiological lengthening.
If the isometric contraction is performed below the maximum available lengthening, the effect will be further shortening of the connective tissue component.
Using a simplified mathematical model of fibre behaviour, during an isometric contraction performed at maximum physiological or relative lengthening, the following will occur:



[Fig. 01]
Black vertical lines: muscle fibre insertions
Blue circles: contractile portions
Red squares: connective tissue portions
A: muscle fibre placed at maximum physiological or relative lengthening
B: active contraction: the blue contractile portions actively shorten and exert traction on the red connective tissue portions
C: at the end of contraction, according to contraction force and duration, each individual connective tissue component will have undergone deformation in lengthening, and the green arrows represent their summation

In isometric contraction at maximum lengthening, the contractile portions undergo deformation in compression, but since their elasticity coefficient is greater than that of the connective tissue portions, the residual shortening of the contractile portions will be less than the residual lengthening of the connective tissue portions.
At the end of treatment, therefore, in order to resolve the residual shortening of the contractile portions, it will be sufficient to use any relaxation technique, since, as already noted, the contractile portion does not undergo true shortening but rather increases in basal tone.
The practical methods for applying these principles depend on the clinician's training and do not fall within the aims of this text.

3. The dual logic of treatment: local and systemic

Systemic muscular shortening may be compared to the lowering of the roof of a house.
To continue standing upright, each person would develop individual adaptive strategies: bending the knees, inclining the trunk, or inclining the head.
Although these strategies are functionally useful in the short term, they maintain and reinforce the problem.
Treatment will be effective only if, by the end of the session, the roof has been raised, allowing more efficient strategies.

A systemic approach alone, however, risks becoming too generic and failing to resolve specific problems.
If a shoulder presents a local mechanical conflict, a specific intervention is necessary to rebalance that region vectorially.
However, the local intervention must occur without producing systemic aggravation.
If the roof does not rise, or even lowers further, the system will tend to return to the previous dysfunctional equilibrium.
As already seen in the chapter on complex systems, a regional corrective action, however technically correct, may produce systemic aggravations greater than the correction obtained locally.

4. The role of muscle strengthening in the biomechanical model

What has been presented so far could be interpreted as a denial of the value of muscle strengthening in rehabilitation. It is essential to clarify that this is not the case.
In the biomechanical model presented here, muscle strengthening is neither excluded nor considered harmful. It simply does not represent the initial phase of treatment when dominant vector shortenings are still present. Under these conditions, muscle strengthening is unable to produce stable mechanical corrections.

The principle is simple and derives directly from vector analysis: a subdominant muscle cannot modify joint alignment as long as the dominant vector opposes a Resistant Force greater than the Working Force that the subdominant muscle can express.
Returning to the example of the shoulder: if dominant internal rotators anteriorly displace the humerus because of shortening of their connective tissue components, strengthening the external rotators alone cannot reposition the humeral head. The external rotators may certainly increase their Working Force, but if the Resistant Force of the internal rotators remains unchanged, the geometric equilibrium does not change.
This does not mean that strengthening is useless or incorrect, but that it requires favourable biomechanical conditions in order to be effective.

4.1 Therapeutic sequence: first recovery of equilibrium, then strengthening

Based on the vector principles presented, the logical therapeutic sequence includes a preparatory phase followed by a consolidation phase.
The preparatory phase focuses on:

- reducing Resistant Force in shortened muscles through prolonged lengthening techniques acting on the connective tissue components;
- rebalancing dominant vectors;
- restoring physiological joint alignment;
- reducing joint conflicts and compensations.

Once coherent joint mechanics have been restored, strengthening becomes fully applicable and performs essential functions:

- consolidating the correction obtained;
- increasing the Working Force of previously subdominant muscles;
- improving functional capacity and system resilience;
- preventing recurrence.

In this sense, the approach described here does not oppose Exercise Therapy: it creates the conditions that allow strengthening protocols to work effectively.

4.2 Why this sequence is necessary

Strengthening applied before vector rebalancing presents several critical issues:

- since it does not modify the Resistant Force of the muscles responsible for joint displacement and leaves the geometry altered, any increase in Working Force by the target muscles, even if possible while they are already developing maximal Resistant Force, would be dissipated in the attempt to oppose dominant forces that have not been reduced;
- it would increase the overall resistance of the system, because in a complex system all elements are interacting and interdependent, and would therefore also increase the Resistant Force of the dominant muscles. The consequence would be worsening of compressive forces on the joint;
- it would probably strengthen a compensatory pattern, because when the neuromuscular system is unable to correct alignment, it always develops alternative strategies that, once strengthened, become more stable and harder to modify.

By contrast, strengthening applied after vector rebalancing:

- stabilizes the recovered joint relationships;
- improves functional performance;
- reduces the probability of recurrence;
- enhances the value of the lengthening work carried out in the previous phase.

Operational conclusion: in the model presented here, strengthening is neither forbidden nor considered harmful, but it belongs to the subsequent phase, when biomechanics have been sufficiently restored. Treatment in lengthening reduces Resistant Force; strengthening, applied at the appropriate time, increases Working Force and consolidates functional stability. These are complementary interventions, not alternative ones.

Clinical examples
Clinically, marked internal rotation of the humerus is observed, and it is decided to proceed with specific lengthening work on the internal rotator muscles.
Technically, this is correct.
But if, while performing the corrective lengthening, the patient co-contracts the levator scapulae, rhomboids, and paravertebrals, the roof lowers.
The system registers an overall increase in tension, and within a few days the humerus returns to internal rotation.
Conversely, working only in a generic way on systemic rebalancing without addressing the specific mechanical conflict generating the symptom may leave the patient feeling "looser," but the shoulder pain persists because the subacromial conflict has not been resolved.

5. Equilibrium as the adaptive solution of the system

The existing equilibrium in each person, however apparently pathological, represents the best solution that the system has found, on the basis of the resources available to it, in order to avoid worse conflicts.
An elevated shoulder, a vertebral rotation, a pelvic inclination are not simply "errors" to be mechanically corrected, but adaptive strategies organized by the subcortical system.
Correcting a visible asymmetry without understanding the systemic logic that generated it may produce conflicts more serious than those that are immediately apparent.

A patient who voluntarily lowers an elevated shoulder in front of a mirror activates the levator scapulae in eccentric shortening, producing rotations of the cervical vertebrae that may generate symptoms.
When intervening on a dysfunctional equilibrium, therefore, one must be certain that what is proposed is truly better than the previous organization.
Improvement is not measured exclusively through the visual appearance of increased symmetry, but also through reduction of overall tension and increased functional efficiency.

6. Operational principles

During treatment, observation of the patient must be continuous, in order to evaluate every regional intervention within the overall context and modify it if necessary.
If the system becomes more rigid, for example, the approach must be changed.
It is necessary to identify the principal dominances that lower the roof and to treat these muscles even if they are not directly related to the symptom.
The latissimus dorsi, for example, may be a priority even in a cervical problem.

The sequence of intervention is not fixed.
Sometimes it is necessary to raise the roof before one can work effectively on the local problem.
At other times, the local problem is so limiting that it must be addressed immediately, but with constant attention to the systemic effects.

By the end of the session, the following should occur:

- improvement of the local problem;
- increase in systemic space;
- overall reduction of muscular tension;
- greater efficiency of movement.

If even one of these elements is missing, the results will be unstable.

7. Conclusions

Treatment of muscular shortening must be simultaneously analytical and systemic.
The aim is not to choose between these approaches, but to integrate them continuously.
Understanding the physical principles presented in the text—the Resistant Force/Working Force relationship, vector dominance, and the characteristics of complex systems—provides the basis for navigating this complexity.
Without these premises, one risks either segmental technicism, which ignores the system, or a generic approach, which fails to resolve specific problems.

The general principles considered above are obviously not fixed protocols, but orienting tools.
Each professional may develop their own therapeutic strategies, verifying that local improvement is accompanied by elevation of the systemic roof, bearing in mind that effectiveness is not measured by the technical perfection of the individual intervention, but by the ability to produce stable, integrated changes without worsening compensations.

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