FUNCTIONAL ISOKINETICS
(OMNIKINETIC RESISTANCE)
A Physical Therapy Perspective

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INTRODUCTION

Physical Therapy is a rapidly expanding field. The options available to the clinical therapist for effecting the health and progress of a given patient are numerous. It is difficult to stay abreast of changes in theory and equipment. Fortunately, one thing does stay the same. Patients have the same parts as they have always had. The job of the clinical therapist is to determine which of these tissues is giving rise to the dysfunction and what "modality" will best address that dysfunction.

Therapeutic exercise, in its many forms, has long been a mainstay of the practice of Physical Therapy. Physical Therapists consider themselves "exercise specialists" in that they are trained to apply various forms of therapeutic exercise for the rehabilitation of their patients. Resistive exercise is but one of the forms of therapeutic exercise employed. It certainly is an important form and is used routinely each day in the average PT clinic. Historically, therapists have had at their disposal three major forms of resistive exercise:

1. isometric
2. isotonic
3. isokinetic

While each of these types of resistance can lead to facilitation of motor units and therefore gains in force production, the effects of training obtained using each method of resistance are different. This does not represent any particular "weakness" of any of the resistances, but rather points up the fact that they are different. What is represented by the differing effect of the resistances is that each has specific purposes and uses. Each resistance is excellent in its place, but no one of these resistances is the answer to all problems which the patient may present. The job of the therapist is to select the resistance which will suit the given set of circumstances. At the risk of sounding self-serving, it should be mentioned that therapists have done fairly well making those clinical decisions. The patients do get better in most cases.

Recently, a fourth major type of resistance has become available to the Physical Therapist. This resistance, which has gone relatively unnoticed, is based on a *HYDRAULIC* principle. Hydra Fitness Industries, Inc., of Belton, Texas, manufactures equipment which is based on this principle. Because this equipment has become increasingly popular in clinical situations, a clear definition of its applications is needed.

The purpose of this paper is to bring *FUNCTIONAL ISOKINETIC* (OMNI-KINETIC -- hydraulic) resistance into perspective for the practicing Physical Therapist. It is furthermore the objective here to suggest clinical situations and types of dysfunctions which may respond very positvely to this type resistance. It is felt that, when the clinician has the necessary information and explanation, he will continue to make the appropriate choice of resistance type for his patient and thereby *FUNCTIONAL ISOKINETICS* (OMNI-KINETICS) will find its place as additional ammunition to attack musculoskeletal and neuromuscular dysfunctions.

REVIEW OF RESISTANCES

While all the resistances mentioned are unique and different, they also possess common ground. No matter what sort of resistance is used, strength of contraction is based on certain common factors;

1. initial length of fibers
2. metabolic condition of those fibers
3. number of recruited fibers
4. type of fibers recruited

The velocity of the contraction is based on how many actomyosin complexes must be formed to move the load and which fiber type is used.

1. if the load is small, contraction is more rapid
2. if the load is great, contraction is slower

Velocity and force are inversely related. This is true for all patients. The clinician must, however, keep in mind that all patients are different. They recruit at differing speeds. The composition of fiber types each patient possess is a genetic situation. Therefore, the resistance chosen to be employed in the rehabilitation of the patient must be specific to the dysfunction *and* to the patient.

At this point, we should discuss the basics of the major resistance types.

ISOMETRIC -- Here the resistance is always equal to or greater than the force generated. The result is a muscle contraction, but no apparent joint angle excursion. Theoretically, the full force possible of a muscle contraction can be obtained with this sort of resistance. However, this force is only achieved at one point in the range. This of course is true if maximal effort is given by the patient.

There are several clinical advantages inherent to *isometric* resistance:

a. easy to apply and readily available
b. very inexpensive
c. reasonably easy for the patient to understand
d. has been proven to increase strength

There are disadvantages:

a. strengthens only one point in range
b. no specificity of training
c. can result in excessive joint shearing/compressive forces

Isometrics are used routinely in the clinic. It has proven helpful in resolving edema, assisting in tissue lengthening efforts and it gives rapid strength and tone gains. *Isometrics* are especially useful in the range restricted post-op patient and in the acutely injured patient when joint movement might exacerbate the injury. The disadvantages can be handled when the clinician applies the resistance in the appropriate situation.

ISOTONIC -- Here the resistance is less that the force generated and therefore the clinician sees joint angle excursion. The limb moves through some or all of the available range. The resistance value stays the same from a static standpoint, but this is not a static event. Consequently, the patient does not experience the same resistance throughout the range owing to the mechanical changes of the joint and soft tissue.

There are also advantages to this resistance:

a. easy to apply
b. has been proven to effect strength gains
c. the patient understands "lifting weights"
d. can be fairly inexpensive

As with *isometrics*, *isotonics* has its clinical limitations:

a. no accommodation of resistance throughout range
b. amount is based on weakest point in range, therefore only weakest point is max overloaded
c. substitution is, very likely, defeating purpose
d. can be dangerous with the unstable joint
e. selecting proper resistance is trial and error
f. loss of specificity for most activity
g. muscle soreness due to eccentric component

The clinician does, of coures, use *isotonics* routinely. It is not the intention here to suggest it should not be used. As before, selection of the proper situation to apply this resistance is the key. The advantages and limitations of the modality must be considered.

ISOKINETICS -- This resistance is electro-mechanical in nature. Theoretically, this resistance is equal to the force generated at any point in the range. A pre-set velocity is chosen, and as long as the patient maintains this velocity and contracts with maximum effort, maximum overload is obtained. The advantages of this resistance are multiple, but perhaps the most important from a clinical standpoint is that the patient who experiences pain can eliminate resistance by stopping his effort against the resistance. This will result in his not attaining the pre-set velocity; therefore, he encounters no resistance.

Even though there are some basic problems with this resistance, it is regarded by many clinicians as being the ultimate in resistance exercise. The following limitations should be discussed.

a. The basic definition of the resistance is obviously in error. It would be impossible for the resistance to be equal to force generated. This is the definition of isometric resistance. Those who employ this resistance know that angular motion occurs during the bout of exercise.

b. The device is said to accommodate to the force the patient generates. Is this the case? The velocity of the contraction is pre-set. It appears that the accommodation is really that of the patient to the machine and not vice versa.

c. The resistance does not consider acceleration and deceleration. One of the basics of training and rehabilitation is that of specificity. Normal human movement is a series of acceleration and deceleration which does not occur with a resistance which is pre-set.

d. With resistive exercise, the clinician wishes to provide maximum overload. The overload obtained with this resistance is only maximum for the speed selected and the fiber type employed.

e. Point of commencement of resistance is questionable. As the patient accelerates his limb to attain the pre-set speed of the resistance, he meets with a static lever arm. Static because it is set to travel at *one* speed. The patient's limb is in a state of acceleration. This acceleration is abruptly haulted. The patient can proceed no more rapidly than the velocity of operator selected. This abrupt halt of acceleration is the definition of an *isometric* moment.

f. This resistance does not consider fatigue in any constructive fashion. When the patient can no longer maintain the pre-set velocity, he loses resistance.

We must, however, be fair to this resistance. Thousands of patients have been treated with this resistance with good success. The testing and rehab protocols used are well established. The resistance is accommodating thoughout *most* of the range. In the hands of a highly skilled and thoroughly versed clinician, some inferences can be drawn as to the type of pathology present when using the device for testing. *Isokinetics* has a place in the rehabilitation of musculoskeletal dysfunction just as the resistance already discussed. It is not, however, the total answer for all situations.

With this review, the focus will now shift to defining and placing *FUNCTIONAL ISOKINETIC* (OMNI-KINETIC -- HYDRAULIC) resistance into a clinical perspective.

FUNCTIONAL ISOKINETIC (OMNI-KINETIC) *RESISTANCE*

The fourth type of resistance is *FUNCTIONAL ISOKINETIC* (OMNI-KINETIC) resistance. This resistance is set up by manipulating the size of an aperture in a fluid filled hydraulic system. The fluid in the system is forced through the aperture as the patient moves a lever arm by virtue of muscular contraction against the lever arm. There is no pre-set speed. The resistance is simply a product of how rapidly and forcefully the patient can move the fluid through the aperture by exerting against the lever arm. The speed (and therefore resistance) can be varied by changing the size of the aperture, but the speed and resistance are still specific to the patient and not the machine, no matter the size of the aperture. The amount of torque generated *and* the speed of which it is generated will be different for each patient at any resistance setting chosen. In other words, the resistance is *patient specific*.

The resistance is totally accommodating throughout the full range of motion. If the patient ceases to exert force, he has no load to handle eccentrically. Maximum overload can be obtained at any speed. As long as maximum effort is given, the patient does not lose overload, no matter his speed. Therefore, fatigue cannot eliminate resistance.

Just as with the aforementioned resistance, *FUNCTIONAL ISOKINETICS* (OMNI-KINETICS) has its place in the treatment of musculoskeletal and neuromuscular disorders. Owing to its unique biomechanical design, *FUNCTIONAL ISOKINETICS* (OMNI-KINETICS) may cross some of the lines of limitations the other resistances cannot.

The following are some examples of clinical applications of this unique resistance.

1. Consideration of Normal Human Movement

As was mentioned earlier, human movement is very plainly a sum result of acceleration and deceleration. When patients are rehabilitated, the clinician must realize this fact and design treatment accordingly. Anyone who has ever treated patients with orthopedic dysfunction has experienced the problem of patients doing well in the controlled clinical setting only to return from the "real world" with resumed symptoms. Patients do not live and work in controlled clinical settings. *FUNCTIONAL ISOKINETICS* (OMNI-KINETICS) allows the patient to meet the stressor at the same velocity as he meets it in the world. This is, *FUNCTIONAL ISOLINETICS* (OMNI-KINETICS) considers acceleration and deceleration: normal human movement. The patient exercises at his speed - not the machine's speed. Therefore, he generates the resistance he is capable of handling. There is no guesswork involved. This is the definition of one of the most basic and important concepts of training: *SPECIFICITY.*

2. No Isometric Moment

Those who deal in the rehabilitation of knee pathology are probably aware of the knee during *isokinetic* exercise. Many feel that patients with anterior glide instability are at risk using *isokinetic* exercise. If one accepts the earlier "acceleration to pre-set speed" arguments, then it becomes easy to see the translatory forces placed on the joint at the *isometric* moment inherent to *isokinetic* resistance. Since *FUNCTIONAL ISOKINETIC* (OMNI-KINETIC) resistance does not involve any pre-set speed which must be attained, the liklihood of *isometric* moment is greatly decreased.

3. Fatigue

The patient seen in the average PT clinic has lost strength and endurance, and fatigues rather quickly. If *isometrics* are used, little is done to enhance endurance throughout the range. If *isotonics* are used, the clinician risks substitution which would decrease the effectiveness of the treatment. Moreover, there is the risk of injury and muscle soreness due to eccentric contractions and the possibility of injury as the patient fatigues and can no longer handle the load we have administered. If *isokinetics* are used, the clinician trains only those fibers used to maintain the chosed pre-set speed.

With *FUNCTIONAL ISOKINETIC* (OMNI-KINETIC) resistance, every resistance setting is an "Endurance" setting. As the patient fatigues, the resistance follows him down. This is because no speed was pre-set, thus the stage is set for a total fiber rehab. The resistance will accommodate the elite athlete who fatigues slowly or the deconditioned patient who fatigues rapidly.

4. Fluid Dynamics

Human joints operate on a fluid principle (synovial fluid). Changing viscosities of that fluid helps to regulate the speed and timing of the joint angular motion. FUNCTIONAL ISOKINETICS (OMNI-KINETICS) uses a similar principle. Certainly an electro-mechanical system cannot be expected to give the smooth, even resistance afforded from a fluid system, which is simply more life-like.

5. The Low Performance Patient

It is not unusual for the sedentary patient commonly seen in the PT clinic to have difficulty keeping pace with the pre-set speeds of *isokinetics*, leaving them with the slower speeds only and no training of faster contractions can be performed. This, of course, cuts down on the effectiveness and specificity of training. Often the clinician resorts to *isotonics* in these cases. Of course, he then must deal with the shortcomings of *isotonic* resistance.

With *FUNCTIONAL ISOKINETICS* (OMNI-KINETICS), this situation need not occur. Here the patient can exercise with maximal overload at whatever speed he can sustain. He is not required to keep pace with a device.

6. Learning

To some this may not be a critical issue, but many clinicians will be able to see the value. It is not unusual for patients to have some difficulty with the concepts of *isokinetic* resistance. The isolated joint movements are foreign and the effort of keeping pace with the device requires training. In the work we have done, patients have had no difficulty whatsoever understanding their task and performing accurately.

7. The Neurologically Involved Patient

It is generally accepted that the patient with upper motor neuron lesion will follow a certain pattern with regard to tone. When confronted with a quick or "Phasic" stretch to the muscle fiber, the tone will increase to abnormally high levels. A more sustained or "tonic" stretch tends to reduce or normalize tone.

With *isometric* resistance, this tonic stretch can be achieved, but at only one point in the range. With *isotonic* resistance, the changing biomechanical advantages throughout the range result in many phasic stretches. With *isokinetics*, the abrupt halt of normal acceleration results in a phasic stretch. Futhermore, most neurologically involved patients cannot attain or sustain the pre-set speeds of this resistance.

FUNCTIONAL ISOKINETIC (OMNI-KINETIC) resistance remains tonic throughout the range. There is no pre-set speed to attain. There is no abrupt halt to acceleration. The changes in biomechanical advantages are accommodated.

CONCLUSION

There is no perfect form of resistance which will meet the needs of every patient. This is why therapists have several types of resistance from which to choose. The choices are wonderful. These options are what makes the practice of Physical Therapy challenging. It is the opinion of this author that *FUNCTIONAL ISOKINETICS* (OMNI-KINETICS) should be considered as a viable option. Not taking advantage of this tool is giving the patient less than he deserves.