

Basics of Exercise Therapy



INTRODUCTION

This chapter includes basics of exercise therapy like axis and plane, lever, types of muscle contraction, muscle work, angle of pull, efficiency of resistance, group action of muscles, types of muscle work and range of muscle work.

FORCE AND ITS PRACTICAL APPLICATION

There are two force vectors.

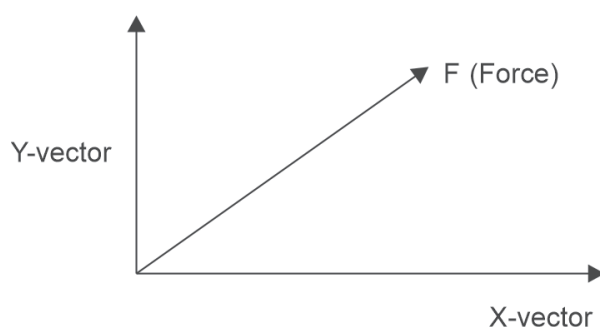


Fig. 1.1: Force vector

In the same way, whenever we apply an external force (manual/mechanical) on the body, it can be divided into two, X and Y components. X-vector will be parallel to the long axis of the bone and Y-vector will be perpendicular to the long axis of bone.

TABLE 1.1: Practical applications of force vectors

Sr. No.	Force (internal/external) angle	X-vector (parallel to long axis of bone) will be responsible for		Y-vector (perpendicular to long axis of bone) will be responsible for	
1.	Greater than 90°	Distraction of joint	F_x in Fig. 1.2	Rotational movement of the joint	F_y in Fig. 1.2
2.	At 90°	—	—	Rotational movement of the joint	$F = F_y$ in Fig. 1.3
3.	Lesser than 90°	Compression of joint	F_x in Fig. 1.4	Rotational movement of the joint	F_y in Fig. 1.4

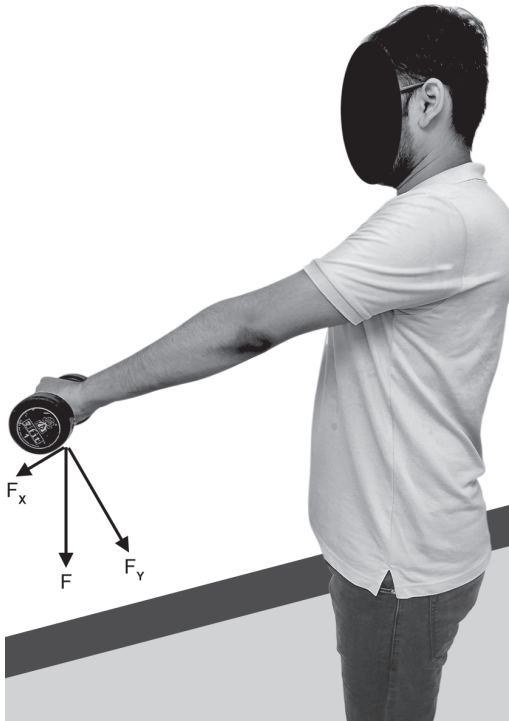


Fig. 1.2: Shoulder flexion with dumbbells, angle is greater than 90 degrees

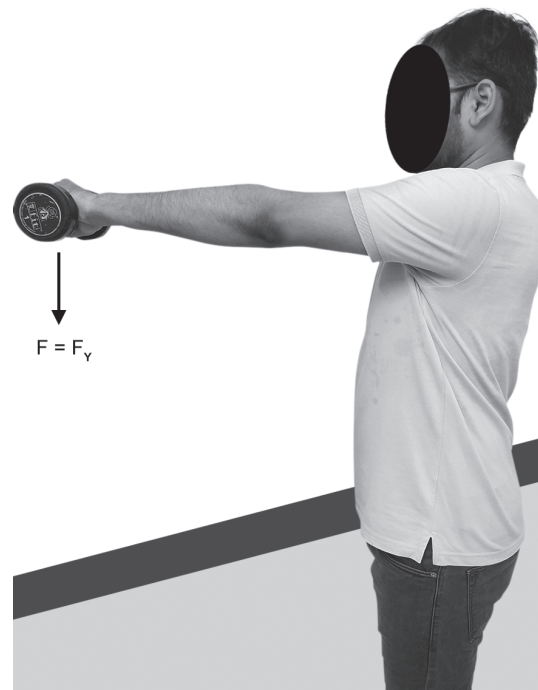


Fig. 1.3: Shoulder flexion with dumbbells, angle is exact 90 degrees

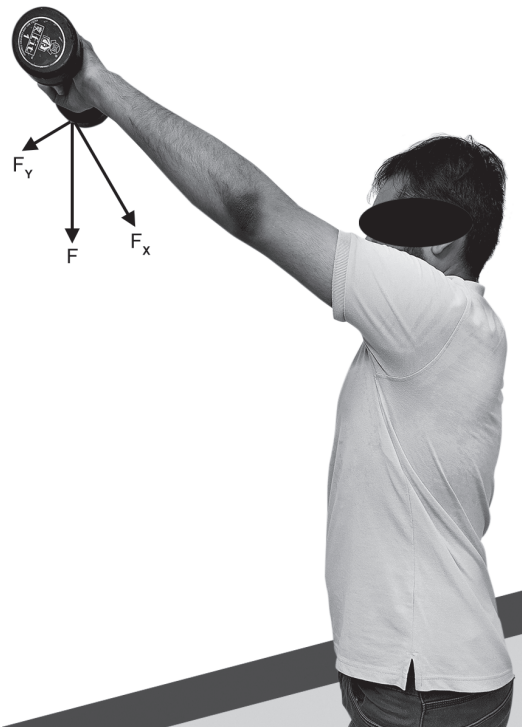


Fig. 1.4: Shoulder flexion with dumbbells, angle is less than 90 degrees

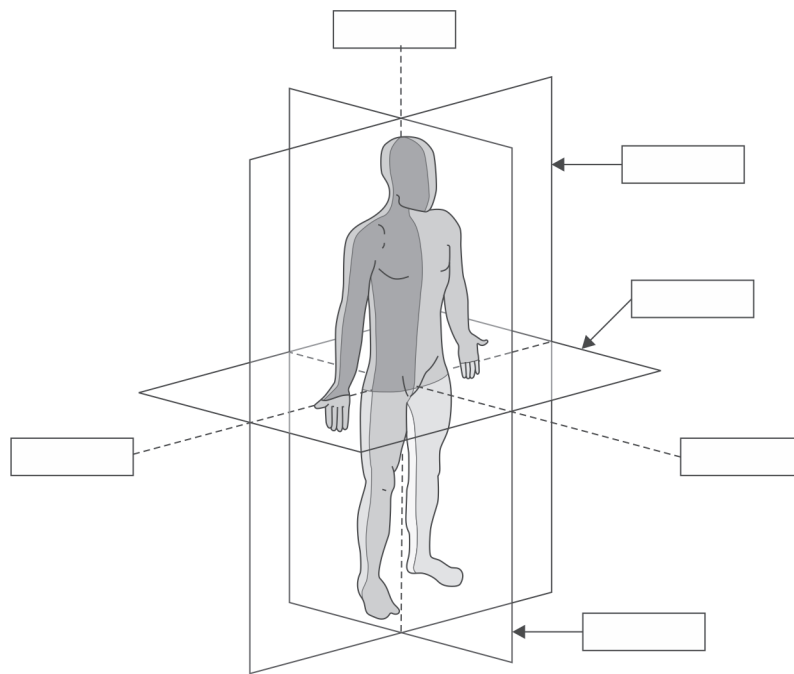
TABLE 1.2: Let's practice			
Sr. No.	Movement	What F_x will do?	What F_y will do?
1.	Shoulder flexion with Theraband (Fig. 1.5)		
2.	Knee flexion with weight cuff (Fig. 1.6)		



Fig. 1.5: Shoulder flexion with Theraband, angle is greater than 90 degrees



Fig. 1.6: Knee flexion with weight cuff, angle is less than 90 degrees

AXIS AND PLANE**Fig. 1.7:** Label axis and plane in the above picture**TABLE 1.3:** Let's practice, axis and plane

<i>Sr. No.</i>	<i>Movement</i>	<i>Axis</i>	<i>Plane</i>
1.	Shoulder internal rotation		
2.	Forearm supination		
3.	Wrist ulnar deviation		
4.	Hip abduction		
5.	Ankle inversion		
6.	Cervical spine rotation		
7.	Lumbar spine extension		
8.	Pelvis anterior posterior tilt		

ANATOMICAL LEVERS

Draw the two figures of first order anatomical lever.

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Draw the two figures of second order anatomical lever.

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Draw the two figures of third order anatomical lever.

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TABLE 1.4: Let's practice, lever type of different movements

Sr. No.	Movement	Lever type
1.	Knee extension by quadriceps	
2.	Shoulder abduction by middle fiber of deltoid	
3.	Hip flexion by iliopsoas muscle	

ANGLE OF PULL

Definition

Mechanical efficiency of a muscle

- The pull is most efficient when the muscle pull is at right angles to the bone.
- As angle of muscle pull decreases below 90 degrees, some amount of force is being used to compress (stabilizing force) the joint and some amount of force works to produce a movement.
- As angle of muscle pull increases above 90 degrees, some amount of force is being used to distract the joint and some amount of force works to produce a movement.

Efficiency of a resistance

- The sustained pull of a force offering resistance will also be maximal when it is applied at right angles to a lever and will decrease as the angle of pull becomes acute or obtuse.
(Please take reference of Table 1.1 for better understanding of angle of pull).

Types of Muscle Contraction

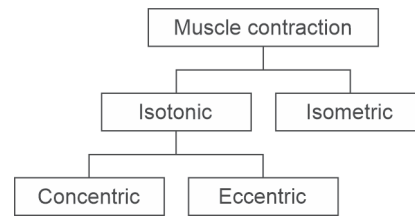


Fig. 1.8: Types of muscle contraction

TABLE 1.5: Length and muscle change in different types of contraction

Types of contraction	Change in length	Change in tension
Isometric		
Concentric		
Eccentric		

TABLE 1.6: Types of muscle work

Work = Force * Distance

Static muscle work	
Concentric muscle work	
Eccentric muscle work	

Range of Muscle Work

Full range:

- Concentric muscle work: The joint is moved as the muscles work from the position in which they are fully stretched, to the position in which they are fully contracted.
- Eccentric muscle work: The joint is moved as the muscles work from the position of full contraction to the position of full extension.

Inner range: The muscle works concentrically from a position in which it is partially contracted to a position of full contraction or vice versa, if it works eccentrically.

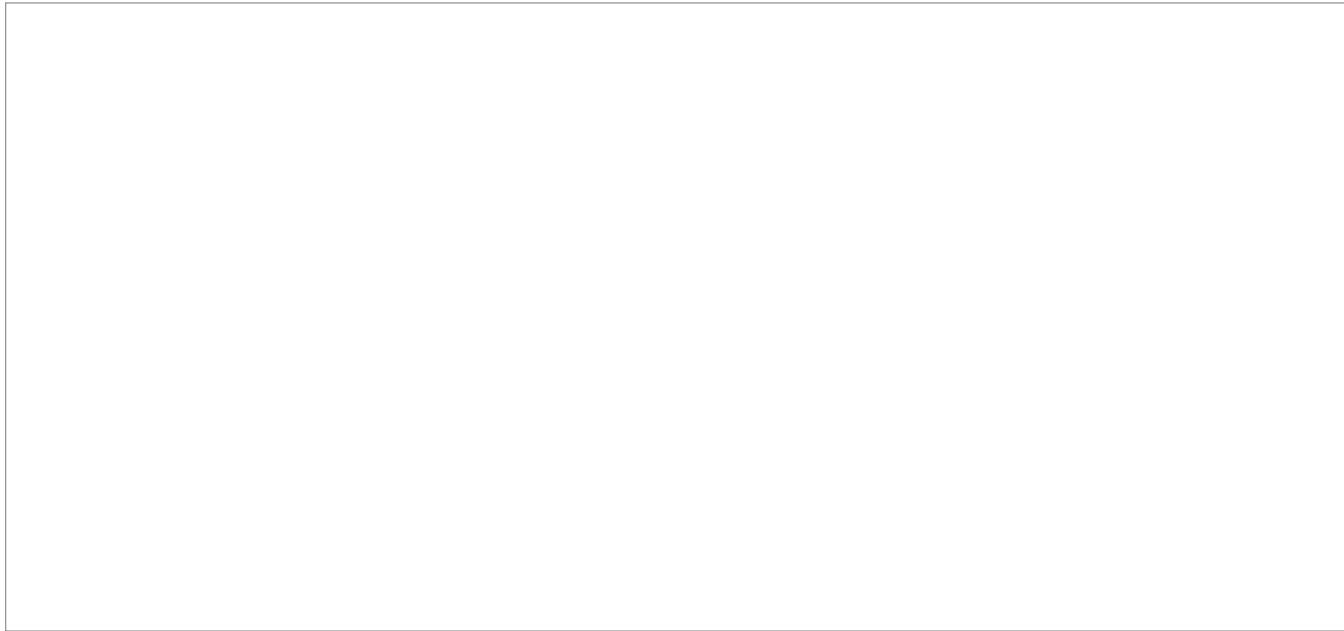
Outer range: The muscle works concentrically from the position in which it is fully stretched to a position in which it is partially contracted or vice versa, if it works eccentrically.

Middle range: The muscles are neither fully stretched nor fully contracted. Muscle works most efficiently in this range and it is mainly used in day-to-day life.

For example: When we do shoulder abduction, deltoid works concentrically, its ranges are as follows:

- 0 to 60 degrees of shoulder abduction: Outer range (fully stretched to partially contracted).
- 120 to 180 degrees of shoulder abduction: Inner range (partially contracted to fully contracted).
- 60 to 120 degrees of shoulder abduction: Middle range (neither fully contracted nor fully stretched).

Figure 1.9: Draw the figure of range of muscle work.

**TABLE 1.7:** Write down range of muscle work for following movements

<i>Sr. No.</i>	<i>Movement</i>	<i>Range</i>	<i>Degree of movement</i>	<i>Status of muscles</i>
1.	Elbow flexion	Inner		
		Middle		
		Outer		
2.	Knee extension from full knee flexion	Inner		
		Middle		
		Outer		

TABLE 1.8: Group action of muscle

Agonists	
Antagonists	
Synergists	
Fixators	

TABLE 1.9: Examples of group of muscle for different movements

Muscle group	Shoulder flexion (for example)	Elbow flexion	Hip flexion
Agonists	Shoulder flexors		
Antagonists	Shoulder extensors		
Synergists	Shoulder abductors and adductors		
Fixators	Scapula stabilizers		

Make Correct Choice

1. **Muscle will work most efficiently in which of this range?**
 - a. Inner range
 - b. Middle range
 - c. Outer range
2. **During pen holding, which type of work will be performed by the muscle?**
 - a. Concentric
 - b. Eccentric
 - c. Static
 - d. None of these
3. **In normal standing position, when shoulder is at neutral position, elbow is fully extended and wrist is in neutral position, holding a 5 kg luggage will cause:**
 - a. Wrist distraction
 - b. Wrist extension
 - c. Wrist compression
 - d. Wrist flexion
4. **Pelvic anterior and posterior tilt occurs in:**
 - a. Frontal plane
 - b. Sagittal plane
 - c. Horizontal plane
5. **Which muscle will work as an agonist during knee extension?**
 - a. Quadriceps
 - b. Hamstring
 - c. Gastrocnemius
 - d. Gluteus maximus

Summary with Key Points

- There are two force vectors. Y is mainly responsible for the rotational movement, whereas X is mainly responsible for compression or distraction of the joint.
- There are three axes and three planes.
- Angle of pull and efficiency of resistance are maximum when it is applied at the right angle.
- Isometric and isotonic are two types of muscle contractions.
- There are three range of muscle work: Inner, middle and outer.
- There are four group of muscles according to their actions: Agonists, antagonists, synergists and fixators.

Bibliography

1. Gardiner, D. (2005). *The Principles of Exercise Therapy*. New Delhi: CBS Publishers & Distributors.
2. Narayanan, S. L. (2005). *Textbook of Therapeutic Exercises*. New Delhi: Jaypee Brothers Medical Publishers.
3. Sivaram, C. (2009). *Principles of Exercises in Physiotherapy*. New Delhi: Jaypee Brothers Medical Publishers.