CHAPTER-2

Starting and Derived Positions

The foundation upon which every exercise is built

LEARNING OBJECTIVES

After studying this chapter, the student will be able to:

1. Define a starting position and justify its importance in therapeutic exercise.
2. Explain the mechanical principles — base of support, centre of gravity, line of gravity and equilibrium — that govern every position.
3. List and explain the factors that determine the stability of a position.
4. Describe the five fundamental positions and, for each, discuss the muscle work, the effects on the body and the therapeutic uses.
5. Explain the four ways in which derived positions are obtained, and the convention for naming them.
6. Discuss the muscle work and clinical uses of the principal derived positions, and apply the principles of support, localisation and progression in selecting a position.

2.1 Introduction

Every movement taught in therapeutic exercise begins from a chosen **starting position** — the posture in which the patient is placed before the exercise is performed. Far from being a trivial preliminary, the starting position is one of the physiotherapist's most powerful tools. It determines how stable the patient is, how much of the body weight is supported, which muscles must work to hold the posture, at which joints movement is free to occur, and how difficult the exercise will feel. A well-chosen starting position makes an exercise safe, comfortable and effective; a poorly chosen one may make the very same exercise impossible, unsafe, or simply useless.

Consider a patient with a weak quadriceps. Asked to straighten the knee in sitting, with the weight of the leg to lift against gravity, they may fail completely and become discouraged. Laid on their side, with the limb supported on a smooth surface so that gravity no longer opposes the movement, the same patient may perform the exercise with ease. Nothing about the muscle has changed — only the starting position — yet the exercise has been transformed from an impossibility into an achievable, confidence-building success. This single example captures why the careful selection of position is woven through the whole of exercise therapy.

DID YOU KNOW?

The systematic classification of starting positions has its roots in the Swedish system of remedial gymnastics developed by Pehr Henrik Ling in the early nineteenth century. Ling's insistence on precise, named starting positions — so that an exercise could be reproduced exactly by any teacher — is the direct ancestor of the terminology, such as “crook lying? and “stride standing?, that physiotherapists still use today.

2.2 The Mechanical Basis of Position

The selection and analysis of any position rest on a few ideas borrowed from mechanics. Understanding them turns the choice of position from guesswork into reasoning.

The **base of support** is the area enclosed by those parts of the body in contact with the supporting surface, *together with the spaces between them*. In standing with the feet apart, the base is not merely the two soles but the whole quadrilateral bounded by their outer borders; this is why spreading the feet so dramatically increases steadiness. The larger the base, the more stable the position.

The **centre of gravity** is the single point at which the entire weight of the body may be considered to act. In the anatomical standing position it lies, in the average adult, just anterior to the second sacral vertebra — roughly at 55–57% of the standing height from the ground. It is not fixed: it rises when the arms are raised, falls when the trunk is bent, and shifts toward any added load, moving outside the body altogether in a position such as deep forward bending.

A vertical line dropped from the centre of gravity to the ground is the **line of gravity**. Stability requires this line to fall *within* the base of support; the more centrally it falls, and the larger the base, the more stable the position. When the line of gravity approaches the edge of the base, balance becomes precarious; when it passes outside the base, the body must either take a step, widen the base, or fall.

KEY TERMS

- **Base of support** — the area of contact with the surface, including the space enclosed between the contact points.
- **Centre of gravity** — the point at which the body weight is balanced (about the level of S2 in standing).
- **Line of gravity** — the vertical line from the centre of gravity to the ground.
- **Equilibrium** — the state in which the forces acting on the body are balanced.

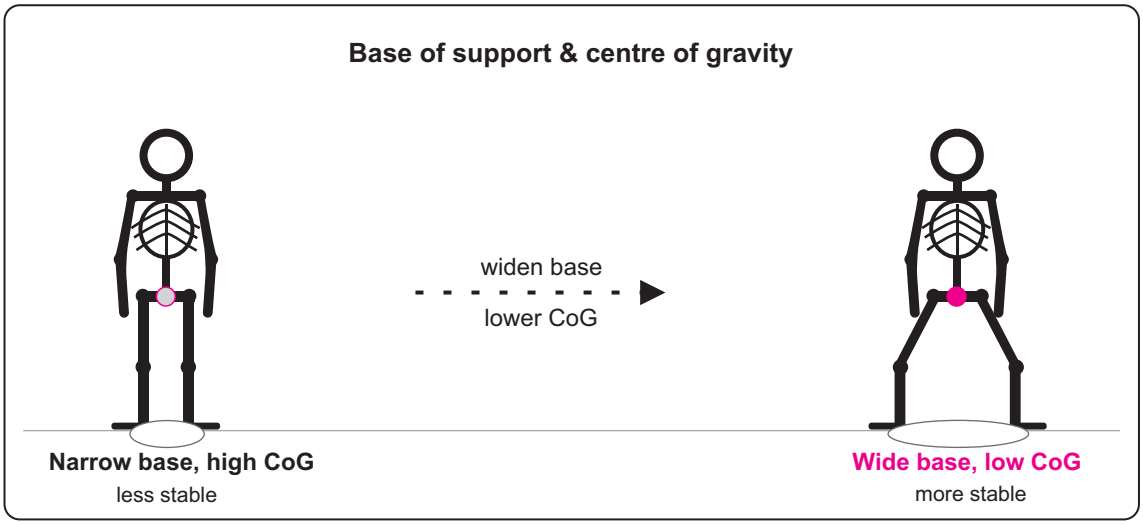

Fig. 2.1 : Stability depends on the base of support and the height of the centre of gravity. A wide base with a low centre of gravity, through which the line of gravity falls centrally, gives the greatest stability; a narrow base with a high centre of gravity is easily overbalanced.

FAST FACT

The centre of gravity sits slightly higher in men than in women, because men carry proportionally more weight in the shoulders and chest and women more in the pelvis. This is one reason why, in many balance tasks, a lower and more pelvis-centred mass can be an advantage.

2.3 Equilibrium and the Factors Determining Stability

A body is in **equilibrium** when the forces acting upon it are balanced. Mechanically, three kinds of equilibrium are described. In **stable equilibrium** a displaced body returns to its original position (a cone resting on its base); in **unstable equilibrium** a small displacement is magnified

and the body topples (a cone balanced on its point); in **neutral equilibrium** the body simply comes to rest in its new position (a ball on a flat surface). Therapeutic positions are chosen to lie wherever is wanted along this spectrum — deeply stable for the weak or fearful patient, deliberately less stable for one whose balance is being challenged.

Four factors determine how stable a given position is:

1. **The size of the base of support.** A larger base is more stable. Spreading the feet, lowering onto the knees, or lying down each enlarges the base.
2. **The height of the centre of gravity.** A lower centre of gravity is more stable. Bending the knees, crouching or lying lowers it.
3. **The position of the line of gravity within the base.** The more centrally the line falls, the more stable the position; stability is lost as the line nears the edge of the base.
4. **The weight of the body.** A heavier body, other things being equal, resists displacement more strongly — which is why a light, frail patient may overbalance where a heavier one would not.

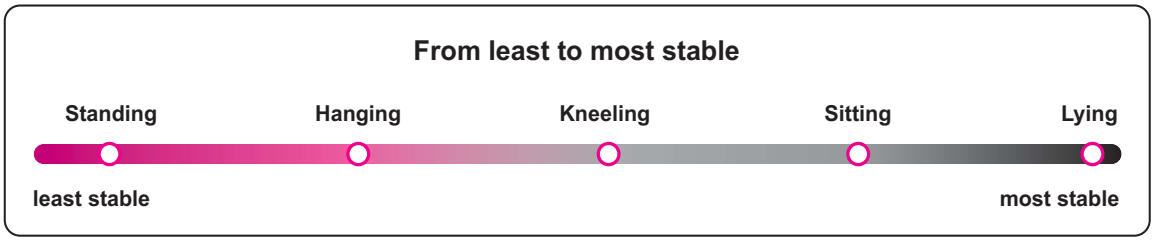

Fig. 2.2 : The five fundamental positions arranged on a continuum of stability, from the least stable (standing) to the most stable (lying). The physiotherapist selects a point on this continuum to match the patient's ability.

CLINICAL PEARL

Every one of these four factors is something the therapist can change. For a patient with poor balance, widen the base (feet apart, a stick, parallel bars), lower the centre of gravity (sitting rather than standing), and keep activities within the base. To progress them, reverse each step in turn — narrow the base, raise the centre of gravity, then ask for reaching beyond the base.

2.4 The Five Fundamental Positions

Classical exercise therapy recognises five **fundamental positions** from which all others are derived: standing, kneeling, sitting, lying and hanging. They are best studied in order of increasing stability. For each it is worth considering four things in turn — the *description* and mechanics, the *muscle work* that maintains it, the *effects* it produces, and its *therapeutic uses*.

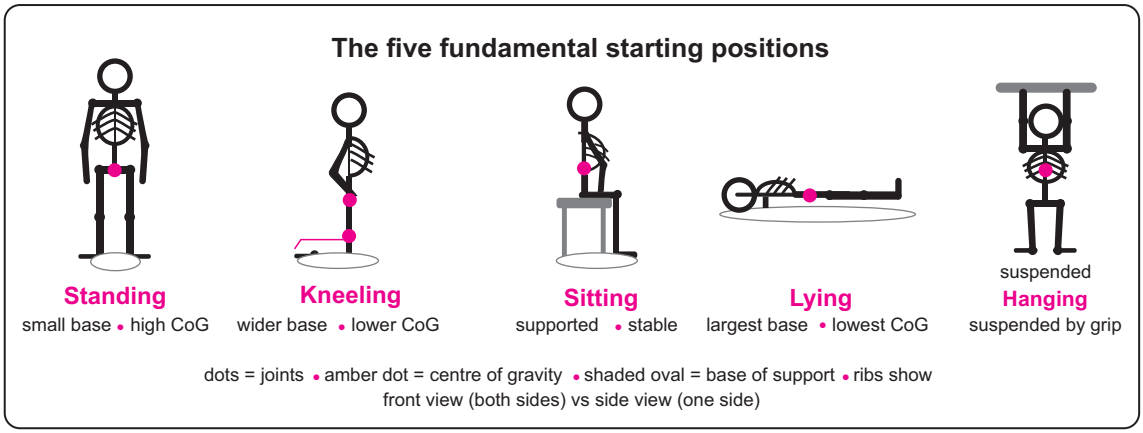

Fig. 2.3 : The five fundamental starting positions, each shown with its base of support (shaded), centre of gravity (amber) and joints (dots). The ribcage indicates the viewpoint — both sides for an anterior view, one side for a lateral view.

2.4.1 Standing

Description. The body is upright, the feet together, the arms by the sides, the head erect and the eyes level. The base is small — only the two feet and the space between them — and the centre of gravity is high, so standing is the **least stable** of the fundamental positions and demands continuous balance.

Muscle work. Standing is maintained by the **antigravity (postural) muscles**, which work **statically** against the constant downward pull of gravity. Because the line of gravity falls slightly in front of the ankle, just behind the hip and just in front of the knee, the body is held not rigidly but in a state of gentle, continuous postural sway. The chief workers are the **plantarflexors of the ankle** (soleus above all, assisted by gastrocnemius), which check the tendency of the body to topple forward; they are aided by the **hip extensors**, the **erector spinae**, and the **extensors of the neck** that balance the head upon the atlas. The knee is held in extension with very little muscle work, the joint being "lockedî close to full extension. The whole arrangement is remarkably economical — postural muscles fire only in brief, intermittent bursts — which is why a healthy person can stand for long periods without tiring.

Effects. Standing is a weight-bearing position. It loads the bones and joints of the lower limb in the manner for which they are designed, helping to maintain bone density; it challenges and so trains the balance mechanisms; and it requires the circulation to return blood against gravity from the legs, a task that depends on the calf-muscle pump.

Uses. Standing is the starting position for balance training, weight transference, gait re-education and the great majority of functional activities of daily living.

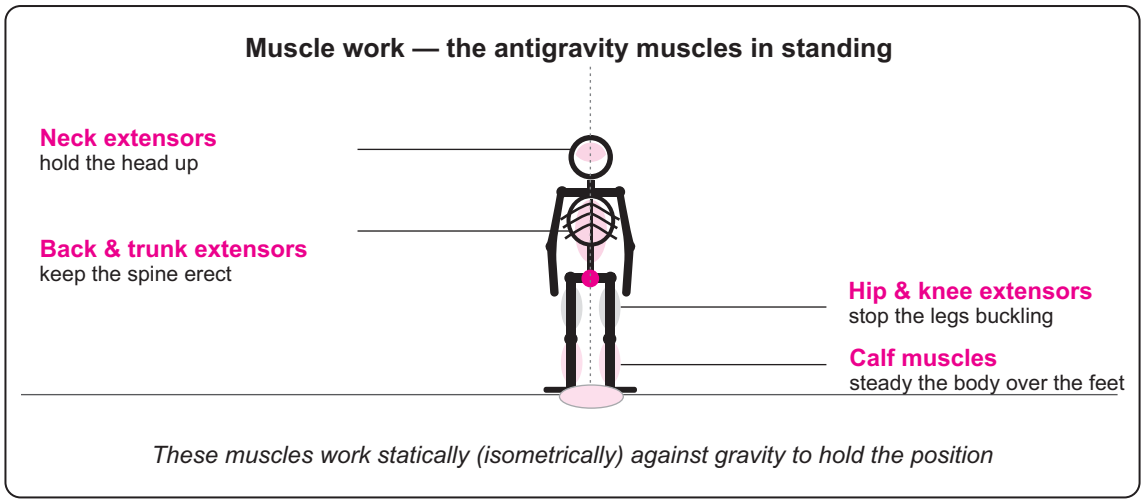

Fig. 2.4 : The chief antigravity muscles that work statically to maintain the standing position — the calf, the hip and knee extensors, the back extensors and the neck extensors. In the more supported positions these same muscles are progressively relieved of their work.

FAST FACT

Quiet standing costs the body only about **10–15% more energy than lying down.** The economy is achieved by the locked knee and by the intermittent, reflex firing of the postural muscles — the soleus, electromyography shows, is almost continuously but only lightly active during quiet stance.

CLINICAL PEARL

The near-effortless “locking? of the knee in standing depends on the final few degrees of extension, in which the femur rotates medially on the fixed tibia — the screw-home mechanism. A patient who cannot fully extend the knee loses this passive lock and must hold the joint with the quadriceps, tiring quickly. Restoring the last few degrees of extension is therefore a priority after knee injury or surgery.

2.4.2 Kneeling

Description. The body is supported on the knees and the front of the lower legs, the hips and trunk erect. The base is larger and the centre of gravity lower than in standing, so the position is more stable, though it still demands active trunk and hip control to remain upright.

Muscle work. The hip and trunk muscles work to hold the body erect over the knees, and balance is maintained by continual small adjustments. Because the long lever of the leg below the knee is removed from the equation, the demand on balance is less searching than in standing but greater than in sitting.

Effects & uses. Kneeling is a valuable intermediate position between sitting and standing. It is used for trunk and balance work, for strengthening the hip and trunk extensors, and as a stage in re-educating the patient toward standing and walking. In its inclined and prone-kneeling derivatives it becomes a position for spinal mobility and core stability work.

2.4.3 Sitting

Description. The patient sits on a firm surface with the thighs fully and evenly supported, the trunk erect, the feet flat on the floor and the knees and hips at a right angle. The base is broad and the centre of gravity moderately low, making sitting a **stable and economical** position that the great majority of patients can sustain in comfort.

Muscle work. The legs are largely at rest; the chief work falls upon the **trunk (back) extensors**, which hold the spine erect against gravity. When the position is well supported — the thighs taking the weight and, if a backrest is used, the spine supported — even this work is reduced almost to nothing.

Effects & uses. Sitting frees the upper limbs, the head and the trunk for exercise while the body weight is comfortably supported. It is, in consequence, the commonest starting position of all — the position of choice for the frail, the elderly and the cardiac or respiratory patient, and for the overwhelming majority of upper-limb, head-and-neck and trunk exercises.

DID YOU KNOW?

Sitting is so widely used that many standard exercise tests and outcome measures are defined in it. Its popularity is no accident: it combines a stable, low-effort base with complete freedom of the arms and trunk, and it is the posture in which most people carry out their daily work — making exercise taught in sitting immediately relevant to everyday life.

2.4.4 Lying

Description. The body is fully supported along its length on a horizontal surface. Lying may be on the back (*supine*) , on the front (*prone*) , or on the side (*sidelying*) . The base is the largest and the centre of gravity the lowest of all the positions, so lying is the **most stable** and the most restful.

Muscle work. Because the supporting surface carries the whole of the body weight, the antigravity muscles are relieved of almost all their work and are able to **relax**. This near-absence of postural muscle work is the defining feature of lying and the source of its therapeutic value.

Effects & uses. Lying is the position of choice for teaching *relaxation*; for the earliest exercises after illness, injury or surgery, when muscle work must be minimal; for breathing and circulatory exercises; and for any exercise that requires the body or a limb to be completely supported. Each variety has its own emphasis: supine lying for general support and abdominal work, prone lying for the back extensors, side lying for abduction and adduction of the limbs free of gravity.

CLINICAL PEARL

The very stability that makes lying so restful brings one hazard: prolonged, motionless lying loads the same skin and soft tissues continuously and threatens pressure injury over bony points such as the sacrum, heels and greater trochanters. Whenever a patient is positioned in lying for any length of time, the therapist must think of regular position change and pressure relief.

FAST FACT

Lying is the body's baseline of energy expenditure — the basal metabolic stateis measured in it. Every other position is costed against this zero, which is precisely why lying is chosen when the aim is to demand as little of the patient as possible.

2.4.5 Hanging

Description. The body is suspended by the hands from a bar or beam, the feet clear of, or only lightly touching, the ground. The “baseî is the grip, and the body weight is taken through the arms and shoulder girdle.

Muscle work. Strong static work is demanded of the **flexors of the fingers** that grip the bar, and of the **muscles of the arm and shoulder girdle** — particularly the depressors and adductors of the scapula — that support the suspended trunk. This is among the most demanding of the fundamental positions and can be sustained only briefly by most people.

Effects & uses. The suspended body weight exerts a *traction* (distraction) effect on the joints of the upper limb and on the spine. Hanging is therefore used to strengthen the shoulder-girdle muscles and, with care and appropriate support, to apply gentle traction to the spine.

FAST FACT

The traction effect of hanging is simply the body's own weight acting as a distracting force. Because that force is considerable and is applied through the shoulders and grip, hanging is used sparingly and is unsuitable for patients with shoulder, wrist or hand problems — for whom mechanical traction offers a more controllable alternative.

Table - 2.1

Position	Base & Cog	Chief Muscle Work	Principal Effects	Typical Uses
Standing	Small base, high CoG — least stable	Antigravity muscles (calf, hip & knee extensors, back, neck), static	Weight-bearing; trains balance; loads the calf pump	Balance, weight transference and gait training
Kneeling	Wider base, lower CoG	Hip and trunk muscles; balance	Removes the long leg lever; intermediate demand	Trunk and balance work; standing re-education
Sitting	Broad base, moderate CoG— stable	Trunk extensors; legs rested	Supports the body while freeing trunk and arms	The commonest position; upper-limb and trunk exercise
Lying	Largest base, lowest CoG — most stable	Least — antigravity muscles relax	Full support; promotes relaxation; basal energy cost	Relaxation, early rehabilitation, breathing exercise
Hanging	Suspended by the grip	Grip, arms and shoulder girdle — strong static	Traction of the spine and upper-limb joints	Shoulder-girdle strengthening; spinal traction

2.5 Derived Positions

A **derived position** is any position obtained by modifying a fundamental one. The fundamental positions are few; the derived positions are almost without number, because each may be altered in several ways at once. Four methods of derivation are recognised.

1. **Altering the base of support** — moving the feet apart (stride standing), one foot forward (walk standing), or together (close standing), so changing the size and shape of the base and therefore the stability.
2. **Changing the position of the limbs** — placing the arms in one of the named arm positions, or moving one leg, so altering the centre of gravity and the muscle work.
3. **Lowering or inclining the trunk** — bending or reclining the trunk, as in half lying or forward-lean sitting, so changing both the support and the demand.

4. **Changing the height of the centre of gravity** — rising onto the toes (toe standing) to raise it, or crouching to lower it.

By long-standing convention a position is named by stating the *modification first and the fundamental position last*. Thus the fundamental word always tells you the base — "…lying", "…standing", "…sitting" — while the first word tells you what has been altered: **crook** lying, **stride** standing, **long** sitting, **half** kneeling.

CLINICAL PEARL

This naming rule is more than a convention — it is a quick analytical tool. Read any position name from its last word backwards: the last word gives the base and therefore the broad level of stability and muscle work, and the first word tells you exactly how that baseline has been modified. "Crook lying" is at once understood as the most stable, fully supported base (lying) with the knees bent up (Crook).

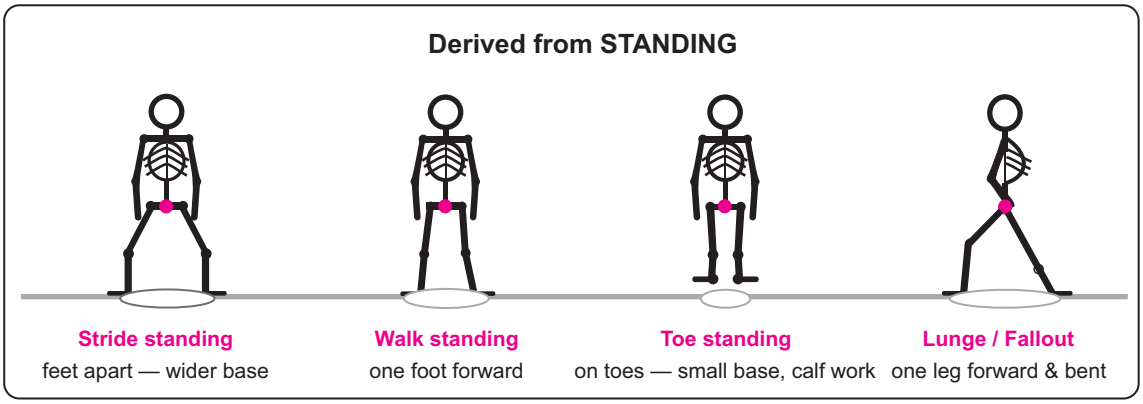

Fig. 2.5 : Positions derived from standing. Spreading or stepping the feet widens the base and adds stability; rising onto the toes raises the centre of gravity and narrows the base, increasing the work of the calf and the demand on balance.

Positions derived from **standing** alter mainly the base and the height of the centre of gravity. *Stride standing* widens the base sideways and is steadier against a lateral push, and so is used for trunk side-flexion and rotation; *walk standing* widens it front-to-back and prepares for gait; *toe standing* raises the centre of gravity and throws strong work upon the calf muscles while making balance distinctly harder; the *lunge* and *fallout*positions combine a wide base with strong work of the forward leg and are used in later balance and strengthening work **(Fig. 2.6, 2.7 & 2.8).**

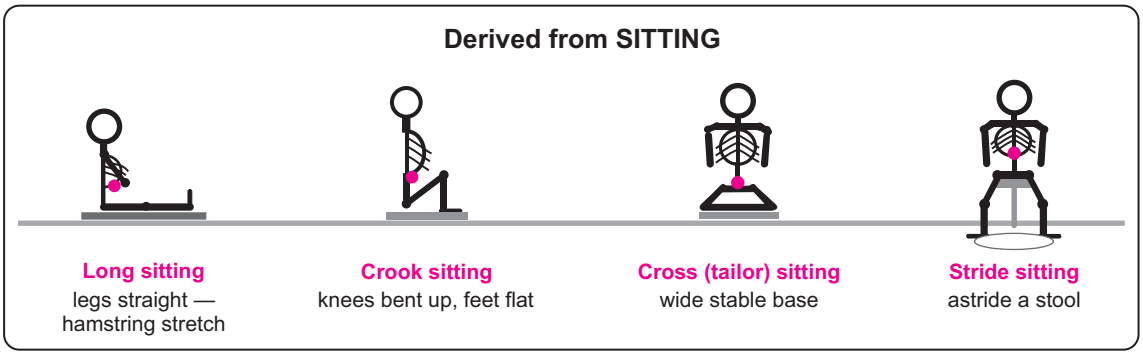

Fig. 2.6 : Positions derived from sitting. Straightening the legs (long sitting) stretches the hamstrings; bending the knees with the feet flat gives crook sitting; crossing the legs (tailor sitting) lowers and widens the base for greater stability.

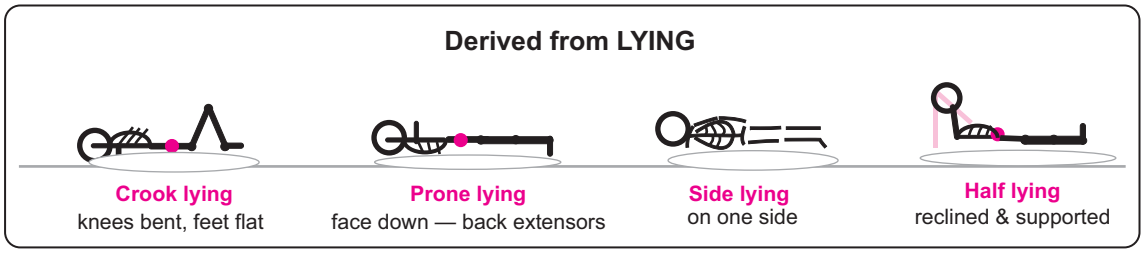

Fig. 2.7 : Positions derived from lying. Bending the knees with the feet flat (crook lying) relaxes the abdominal and back muscles; turning prone loads the back extensors; reclining against a support gives the comfortable, well-supported half-lying position used for breathless patients.

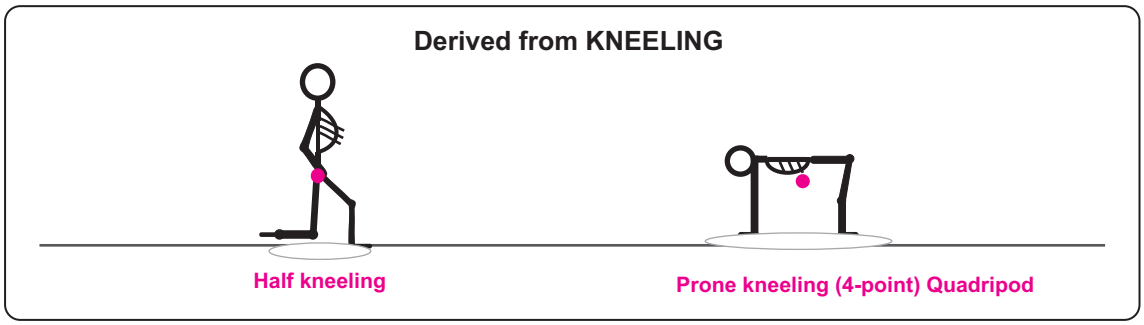

Fig. 2.8 : Positions derived from kneeling. Half kneeling is a balance and functional position that also stretches the hip flexors; prone kneeling (the four-point position) gives a large base with the spine held horizontal, ideal for trunk-mobility and core-stability work.

The **arm positions** deserve special mention, for they are the commonest of all derivations. By moving the arms from the side of the body, the centre of gravity is raised and the work of the trunk increased; the named positions — *wing* (hands on the waist), *bend* (fingers to the shoulders), *reach* (arms forward), *yard* (arms abducted to the horizontal) and *stretch* (arms raised overhead) — provide a graded series of increasing demand that can be added to any position of the trunk or legs.

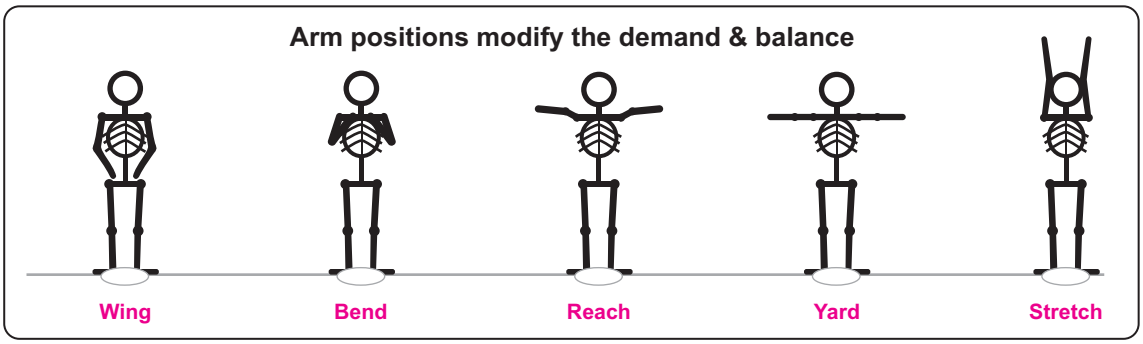

Fig. 2.9 : The named arm positions — wing, bend, reach, yard and stretch — derive new positions by altering the upper limbs. Each successive position raises the centre of gravity a little further and increases the work the trunk must do to keep the body balanced.

DID YOU KNOW?

Simply raising the arms overhead into the "stretch" position measurably increases the work of the trunk and the difficulty of balance, because it lifts the centre of gravity. This is why a therapist can make a standing or sitting balance exercise progressively harder without moving the feet at all — merely by changing where the arms are held.

Table - 2.2

Derived Position	How It Is Derived	Muscle Work	Chief Use
Stride standing	Standing, feet apart	As standing, with greater lateral stability	Trunk side-flexion and rotation
Toe standing	Standing, raised on the toes	Strong static work of the calf; high balance demand	Calf strengthening; balance training
Crook lying	Lying, hips and knees bent, feet flat	Relaxes the abdominal and back muscles	Abdominal exercise, pelvic tilting, relaxation
Prone lying	Lying face down	Work of the back extensors	Back extension; postural correction
Half lying	Lying reclined on a support	Little; well supported	Cardiac and respiratory patients; comfort
Long sitting	Sitting, legs straight out	Trunk extensors; hamstrings on stretch	Hamstring stretch; trunk exercise
Half kneeling	Kneeling on one knee, other foot forward	Balance work; hip-flexor stretch	Balance and functional re-training
Prone kneeling	On hands and knees (four-point)	Trunk and shoulder-girdle stabilisers	Spinal mobility and core control

2.6 Choosing and Progressing a Position in Practice

The physiotherapist chooses a starting position deliberately, weighing several purposes at once. The same exercise can be made safer, more comfortable, more specific or more demanding simply by changing where the patient starts from.

Support and stability come first for the weak, the painful or the unwell: a stable, well-supported position spares the patient unnecessary effort and fear. **Localisation** — achieved by fixing the body or a proximal part — ensures that movement occurs only at the joint being treated, and not through unwanted "trick" movements elsewhere. **Progression and regression** are obtained by altering the base or the centre of gravity, so that one exercise can be graded across many sessions. A position may also be chosen for **specific muscle work** — to load or to rest a particular group — for **comfort and relaxation**, or for its **functional relevance** to the patient's daily life.

REMEMBER

- The starting position decides stability, support, muscle work and the freedom of movement.
- Stability rises with a larger base, a lower centre of gravity, a central line of gravity and greater weight.
- The five fundamentals run from least stable (standing) to most stable (lying).
- Derived positions modify a fundamental by altering the base, the limbs, the trunk or the centre of gravity.
- Name a position by its modification first and its fundamental last.
- To make an exercise easier, move toward support; to make it harder, move away from it.

PRECAUTIONS

- Change position slowly, especially from lying to standing, to avoid the dizziness of a sudden fall in blood pressure (orthostatic hypotension).
- Ensure that any supporting surface — plinth, stool or bar — is stable and at a safe height before use.
- Guard the patient whenever a less stable position is used, and keep activities within a safe base until balance is proven.
- Avoid prolonged, motionless positions that threaten pressure areas or joint stiffness.

SUMMARY

The starting position is the foundation upon which every therapeutic exercise is built. Its analysis rests on a handful of mechanical ideas — the base of support, the centre of gravity, the line of gravity and the conditions for equilibrium — from which the stability of any position can be reasoned rather than guessed. Five fundamental positions, from the least stable standing to the most stable lying, differ in their base and centre of gravity and therefore in the muscle work that maintains them, in their effects upon the body, and in their therapeutic uses. From these, an unlimited variety of derived positions is created by altering the base, the limbs, the trunk or the centre of gravity, each modification changing the muscle work in a way the mechanics make wholly predictable. A secure grasp of these principles allows the physiotherapist to choose, for every patient and every exercise, a position that is at once safe, comfortable, specific and effective — and to progress it, step by reasoned step, as the patient improves.

End-of-Chapter Self-Assessment

A· Multiple-Choice Questions — choose the best answer.

Q1· In the anatomical standing position the centre of gravity lies approximately at the level of the…

A· First lumbar vertebra
B· Second sacral vertebra
C· Xiphisternum
D· Hip joint

Q2· Which fundamental position is the least stable?

A· Standing
B· Sitting
C· Lying
D· Kneeling

Q3· The muscles chiefly responsible for quiet standing work…

A· Concentrically
B· Eccentrically
C· Statically (isometrically)
D· Not at all

Q4· Which is NOT a factor determining the stability of a position?

A· Size of the base
B· Height of the centre of gravity
C· Colour of the surface
D· Position of the line of gravity

Q5· The chief muscle checking forward sway in standing is the…

A· Soleus B· Rectus abdominis

C· Biceps D· Tibialis anterior

Q6· In which position do the antigravity muscles do the least work?

A· Standing B· Hanging

C· Lying D· Kneeling

Q7· "Crook lyingî is derived from which fundamental position?

A· Sitting B· Standing

C· Lying D· Kneeling

Q8· Hanging exerts which effect on the spine?

A· Compression B· Traction (distraction)

C· Rotation D· No effect

Q9· Raising the arms into the "stretch" position makes a balance task harder because it…

A· Lowers the centre of gravity B· Raises the centre of gravity

C· Widens the base D· Has no effect

Q10·By convention a position is named by stating the…

A· Fundamental position first, modification last

B· Modification first, fundamental position last

C· Muscle worked first

D· Joint angle first

Answer key:

1-b, 2-a, 3-c, 4-c, 5-a, 6-c, 7-c, 8-b, 9-b, 10-b.

B· SHORT- ANSWER & ESSAY QUESTIONS

1. Define a starting position and explain the four factors that determine the stability of a position.
2. Describe in detail the muscle work, effects and uses of the standing position.
3. Compare the muscle work required in sitting with that required in lying, and account for the difference.
4. What is a derived position? Explain, with examples, the four ways in which derived positions are obtained.
5. Discuss the muscle work of any four derived positions and state a therapeutic use of each.
6. Explain how the principles of support, localisation and progression guide the choice of a starting position in clinical practice.

References & Further Reading

PRESCRIBED TEXTBOOKS

1. Gardiner MD. *The Principles of Exercise Therapy*. CBS Publishers & Distributors, Delhi.
2. Hollis M. *Practical Exercise Therapy*. Blackwell Scientific Publications, Oxford.
3. Kisner C, Colby LA. *Therapeutic Exercise*: *Foundations and Techniques*. F. A. Davis, Philadelphia.
4. Kendall FP, McCreary EK, Provance PG. *Muscles*: *Testing and Function with Posture and Pain*. Williams & Wilkins, Baltimore.

REFERENCE BOOKS & GUIDELINES

5. Basmajian JV, De Luca CJ. *Muscles Alive*: *Their Functions Revealed by Electromyography*. Williams & Wilkins, Baltimore.
6. Levangie PK, Norkin CC. *Joint Structure and Function*: *A Comprehensive Analysis*. F. A. Davis, Philadelphia.
7. Smith LK, Weiss EL, Lehmkuhl LD. *Brunnstrom¼s Clinical Kinesiology*. F. A. Davis, Philadelphia.
8. National Commission for Allied and Healthcare Professions. *Curriculum Handbook of Physiotherapy*. Ministry of Health and Family Welfare, Government of India.