

The Physiology of the Joints

I. A. KAPANDJI

Translated by

L. H. HONORÉ, B.Sc., M.B., CH.B., F.R.C.P.(C.)

Preface by

PROFESSOR F. POILLEUX (Broussais Hôpital, Paris)

Second Edition

Volume I

UPPER LIMB



The Physiology of the Joints

Annotated diagrams of the mechanics of the human joints

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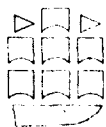
Second Edition

Volume 1

UPPER LIMB

- 1 The Shoulder
- 2 The Elbow
- 3 Rotation (Pronation and Supination)
- 4 The Wrist
- 5 The Hand and the Fingers

With 346 illustrations by the Author



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PREFACE TO THE FRENCH EDITION

This book, first of a series of three, has a new and very unusual approach: the author is setting out to give the reader an understanding of the mechanics of the joints with the help of diagrams rather than of a text.

The commentaries are short; the quality, clarity and simplicity of the drawings and diagrams are such that they could be understood without any verbal explanation. Although Dr A. Kapandji first gives us diagrams taken from classical treatises on anatomy, he adds drawings which are very much his own. With his very great knowledge of anatomy and his gift for faithful simplification he can show by these drawings the mechanics of the joint being studied.

Dr A. Kapandji of course intends this book to be helpful to physiotherapists but the student of medicine will find it a necessary and very useful complement to the university course in general physiology of the joints. Surgeons will find ideas of interest for operations which aim to re-establish or re-create normal mechanics in damaged joints.

The drawings are unusually clear: everything which could hinder understanding has been removed and one feels that the author has foreseen the difficulties which the student could encounter. Each time a problem arises it is explained by a diagram which, though simplified, is extremely clear.

The accompanying text which has been included purely for descriptive purposes is short, concise and very well adapted to the author's purpose which is to exploit visual memory to the utmost.

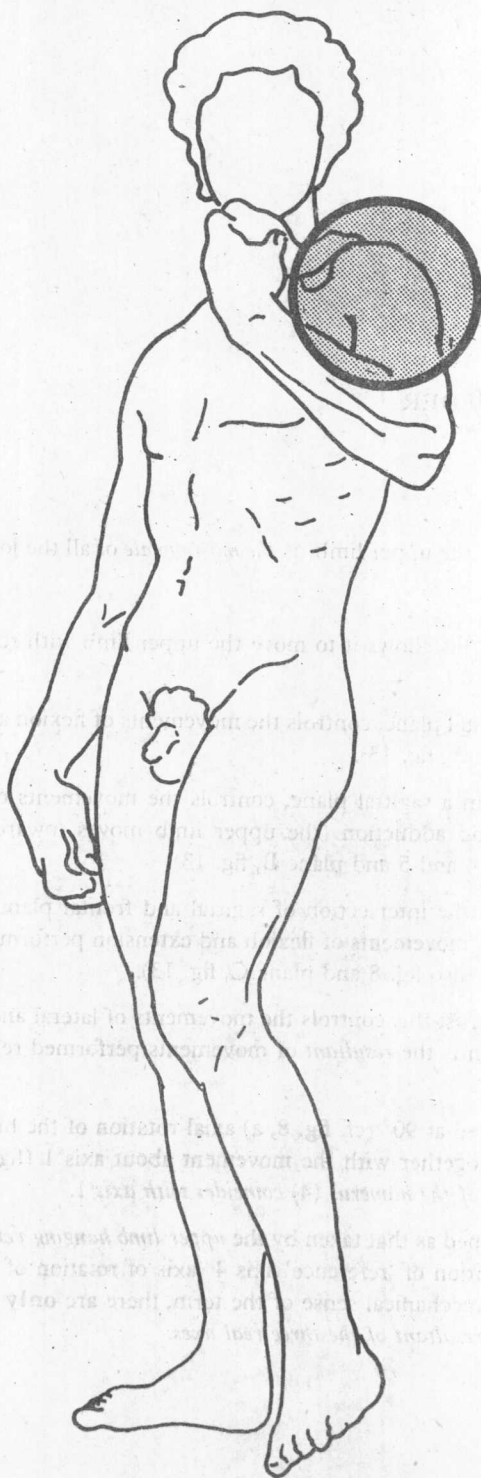
Professor FELIX POHLEUX

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References will be listed in the last volume.



THE SHOULDER

THE SHOULDER

PHYSIOLOGY OF THE SHOULDER

FIGURE 1 (p. 9)

The shoulder, the **proximal joint** of the upper limb, is *the most mobile* of all the joints in the human body.

FIGURE 2

It has **three** degrees of freedom and this allows it to move the upper limb with respect to the *three planes in space*.

1. **Transverse axis**, lying in a frontal plane, controls the movements of flexion and extension performed in a *sagittal plane* (cf. fig. 3 and plane A, fig. 13).

2. **Antero-posterior axis**, lying in a sagittal plane, controls the movements of abduction (the upper limb moves away from the body) and adduction (the upper limb moves towards the body) which are performed in a *frontal plane* (cf. figs. 4 and 5 and plane B, fig. 13).

3. **Vertical axis** running through the intersection of sagittal and frontal planes and corresponding to the third axis in space. It controls the movements of flexion and extension performed in a *horizontal plane*. While the arm is abducted to 90° (see also fig. 8 and plane C, fig. 13).

4. **Longitudinal axis** of the humerus: this controls the movements of lateral and medial rotation of the arm (see also fig. 6); this axial rotation is the *resultant* of movements performed relative to the other three axes *taken two at a time*.

Example: when the arm is abducted at 90° (cf. fig. 8, a) axial rotation of the humerus results from the movement about axis 2 (abduction) together with the movement about axis 1 (fig. 2). In this position of abduction at 90° *the longitudinal axis of the humerus (4) coincides with axis 1*.

The **position of reference** is defined as that taken by the *upper limb hanging vertically at the side of the trunk*. Note that in this so-called position of 'reference' axis 4 (axis of rotation of the humerus) coincides with the vertical axis 3. Thus in the mechanical sense of the term, there are **only three axes** at this joint and not four; *the fourth is merely the resultant of the three real axes*.

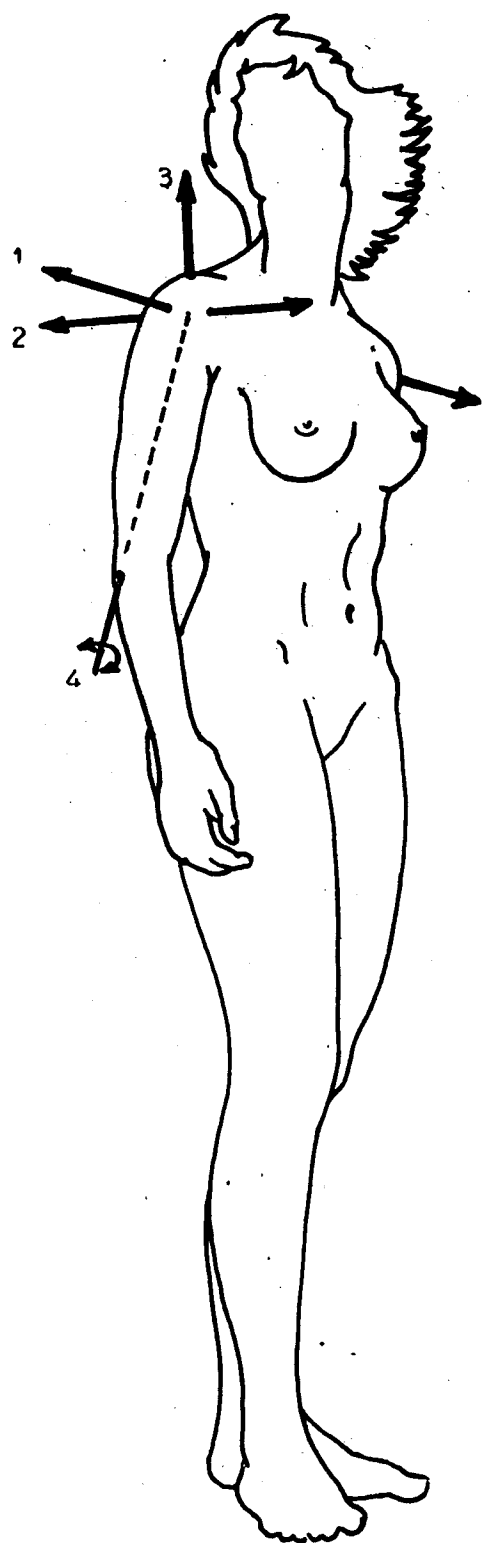


FIGURE 3

Movements of flexion and extension

performed in a *sagittal plane* (plane A, fig. 13) about a *transverse axis* (1, fig. 2):

- (a) Extension to 45° to 50° .
- (b) Flexion to 180° (it should be noted that the position of flexion at 180° can also be defined as abduction at 180°).

FIGURE 4

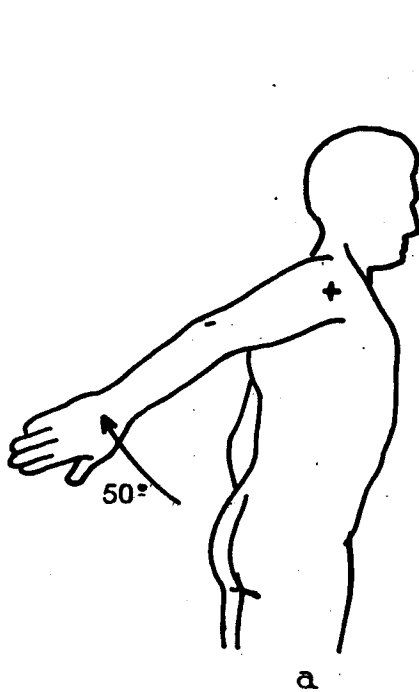
Adduction

Adduction in the frontal plane starting from the position of reference (i.e. absolute adduction) is mechanically impossible *owing to the presence of the trunk*.

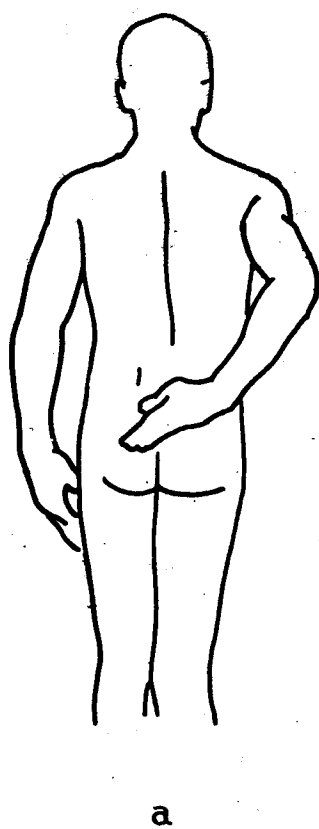
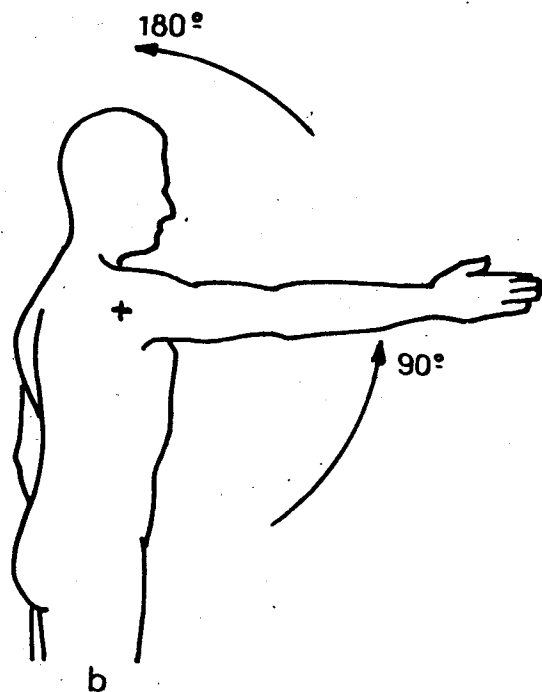
Starting from the position of reference, adduction is only possible when combined with:

- (a) Extension: this allows a trace of adduction.
- (b) Flexion: in this case adduction can reach 30° to 45° .

Starting from any position of abduction, adduction, in this case called '*relative adduction*', is always possible, in the frontal plane, up to the position of reference.



3



4

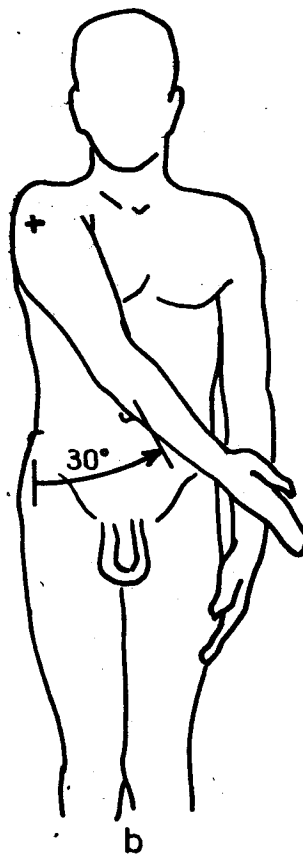


FIGURE 5

Abduction

Abduction, the movement of the upper limb away from the trunk, takes place in a *frontal plane* (plane B, fig. 13), about an *antero-posterior axis* (axis 2, fig. 2). When abduction reaches 180° the arm is vertically above the trunk (d).

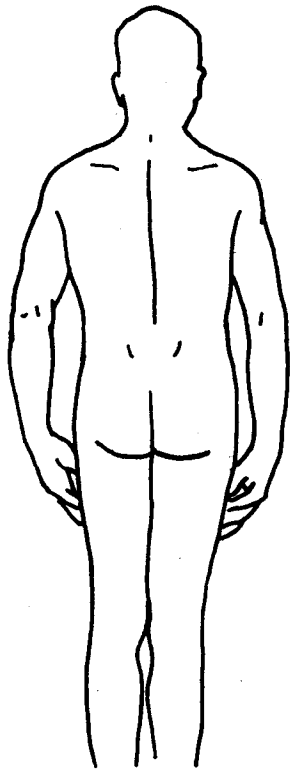
Two points must be noted:

After the 90° position, the movement of abduction brings the upper limb once more closer to the sagittal plane of the body.

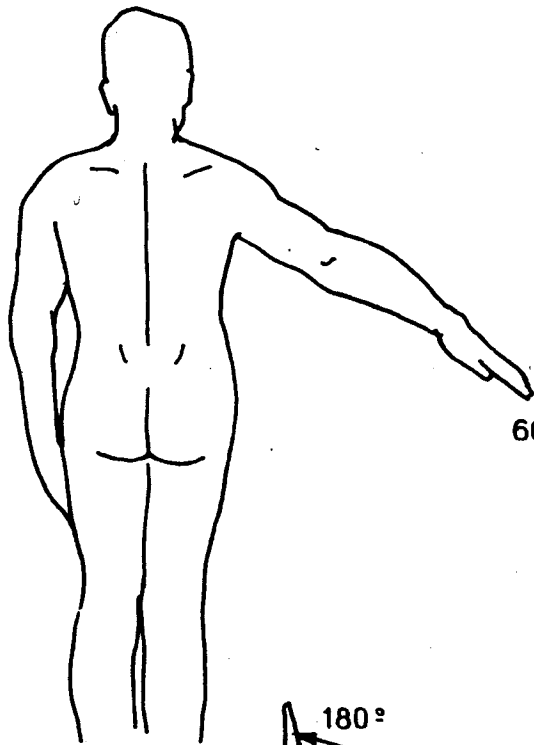
The final position of abduction at 180° can also be achieved by flexion to 180°.

From the point of view of the muscles and of the movements at the joints, abduction, starting from the position of reference (a), passes through three stages:

- (b) Abduction to 60°.
- (c) Abduction to 120°.
- (d) Abduction to 180° (cf. figs. 54, 55 and 56).

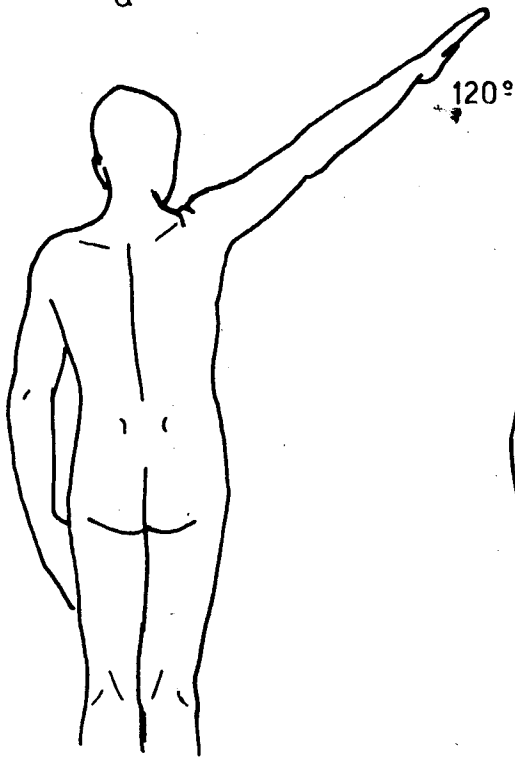


a



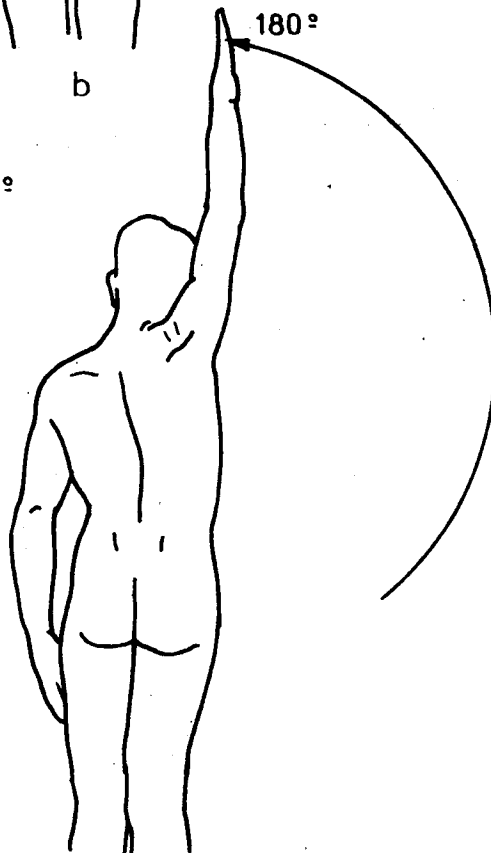
60°

b



120°

c



180°

d

FIGURE 6

Axial rotation of the arm

(seen from above)

This occurs about the *longitudinal axis* of the humerus (axis 3, fig. 2).

(a) Position of reference (rotation 0°): in order to measure the range of the movements of rotation *the elbow must be bent at 90°* , the forearm thus lying in a sagittal plane. Otherwise the range of the movements of rotation would also include that due to pronation and supination of the forearm.

(b) Lateral rotation: to 80° , i.e. falling short of 90° .

(c) Medial rotation: to 95° , i.e. slightly exceeding 90° .

For medial rotation to reach this far, *the forearm must be pulled behind the trunk*, and this introduces a certain degree of extension.

FIGURE 7

Movements of the shoulder girdle in the horizontal plane

These movements also involve movements of the scapula on the thorax. In the diagram:

(a) Position of reference.

(b) Backward movement of shoulder girdle.

(c) Forward movement of shoulder girdle.

The range of the forward movement is *greater* than that of the backward movement. The muscles involved in these movements are as follows:

For forward movement: pectoralis major, pectoralis minor, serratus anterior.

For backward movement; the rhomboid muscles, trapezius (the transverse fibres), latissimus dorsi.