Recurrent Dislocation of the Shoulder

Physiopathology and Operative Corrections

Amulya K. Saha

2nd Revised Edition

61 Illustrations, 13 Tables

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1981

Georg Thieme Verlag
Stuttgart · New York

Thieme-Stratton Inc.
New York

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CIP-Deutsche Bibliothek Cataloguing in Publication Data

Saha, Amulya K.:

Recurrent dislocation of the shoulder : physiopathology and operative corrections / Amulya K. Saha. – 2. rev. ed. – Stuttgart ; New York : Thieme; New York : Thieme-Stratton, 1981

1. Aufl. bei Academic Publishers, Calcutta
u. d. T.: Saha, Amulya K.: Recurrent anterior dislocation of the shoulder.

1st English edition 1969 (Academic Publishers, Calcutta)
1st German edition 1978 (Enke, Stuttgart)

Printed in West Germany by Karl Grammlich, Pliezhausen

ISBN 3-13-612702-1 (Georg Thieme Verlag, Stuttgart · New York)
ISBN 0-86577-043-3 (Thieme-Stratton, Inc., New York)
LC 81-51919

Preface to the Second Edition

When first published over a decade ago*, this work was warmly received in various places, especially in the U.S., West Germany and the Scandinavian countries. With further understanding of the biomechanics and the dynamic stability of the shoulder, a revised edition has become a necessity.

The chapters on the mechanics of the shoulder, especially the action of the intermediate group of muscles, dynamic stability including experimental production of dynamic instability, and determination of retrotorsion in the living, have been rewritten.

With the increase in the number of cases to 164, the chapters on latissimus dorsi tranfer, rotation osteotomy and increase in posterior glenoid tilt have been modified. Torsion osteotomy included cases where internal rotation of the distal fragment was done. Indications for the first two operations have been revised.

Though the number of cases of recurrent posterior dislocation were few, and all were voluntary, a chapter on this has been included within the common ambit of dynamic posterior instability. Four operations were performed – with good results in three cases of this type – and the others refused operations because of the absence of pain and inconvenience.

Lastly, an epilogue has been added to afford a glance into the future of the total shoulder replacement, with illustrations based on the concept of the dynamic stability of the shoulder joint.

As literature on the subject has increased since the time of the earlier edition, relevant references to some significant new works have been included. In this connection, I owe an apology to Dr. Carter R. Rowe, whose masterly article (1956) was missed in the first edition. It has been referred to on several occasions in this edition.

I convey my thanks to Prof. B.K. Banerjee for constructive criticism, Dr. S.K. Dutta for his new drawings, and to Dr. D. Bhattacharya and Dr. A Mukherjee without whose help the publication of this edition would not have been possible.

My sincere thanks are due to my publishers Ferdinand Enke Verlag for their helpful advice and translation, and also to the Georg Thieme Verlag for their help in publishing the English edition.

Calcutta 1981

A.K. Saha

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* Academic Publishers, Calcutta 1969

Contents

Introduction

Almost everything has long been known about the underlying lesions, predisposing factors and the mechanism of the recurrent anterior dislocation of the shoulder. More than 250 operations were devised for its cure (Magnuson and Stack 1943), and yet some of the pertinent questions that arise in this connection remained unanswered. Lack of fundamental research on the dynamic stability of the shoulder joint was perhaps the reason.

Axial radiography of the shoulder joint through the axilla shows increasing protrusion of the articular surface of the head of the humerus against the anterior capsular mechanism during abduction of the arm. This protrusion increases with enhanced retrotorsion of the upper humerus. In the overhead position of the arm the whole of the articular surface of the humerus lies against the anterior capsule, except for a small area near the lesser tuberosity which is in contact with the articular surface of the glenoid. The precariousness of this critical stage is aggravated if the limb is abducted in extension, thus adding to the magnitude of the problem. Stabilizing factors are needed to retain the head in the glenoid during this phase. This led me to the idea of an extra force which, when suitably harnessed, could roll the head of the humerus backwards and thus add to the stability of the shoulder joint. With this in view, in 1956, I transferred the latissimus dorsi in an epileptic from bilateral anterior recurrent dislocation of the shoulder. To my satisfaction, I found that this procedure could, during a subsequent relapse of epileptic fit in the patient, hold the head of the humerus and prevent it from dislocating on the side operated upon, though the dislocation recurred on the side where the patient had undergone an earlier Bankart's operation. I then explained this from the standpoint of one of the traditional concepts of the etiology of the recurrent anterior shoulder dislocation, viz., insufficiency of subscapularis force, perhaps due to elongation of its tendon (Saha 1958). At that time I did not dare disturb 70 years of accumulated knowledge and experience.

As time passed, I went deeper into the problem of the stability of the shoulder joint in motion (dynamic stability). Studies of various types of chronic postpolio paralysis of the shoulder, including postpolio flail shoulder (Saha 1967), and the results of operations performed established that the shoulder needed a three-directional stability during movement. Later on it was shown that the short rotators, since renamed steerers, are the muscles which not only steer the head of the humerus to change the fulcrum but also ensure stability during movement. Glenoid retrotilt and humeral retrotorsion, besides the force of the horizontal steerers, the subscapularis and the infraspinatus, govern the horizontal dynamic stability of the shoulder. The factors governing stability thus established required determination in the living. While we have been partially successful in determining the first two by radiological methods, a lot still remains to be found out in connection with the determination of the force of the horizontal steerers.

On the basis of the fundamental concept of the stability of the shoulder, operations have been introduced to increase the force of the horizontal steerers, to reduce the retrotorsion of the upper end of the humerus and to increase the tilt of the glenoid for the treatment of the recurrent anterior dislocation of the shoulder. Perhaps the time has now come for us to be able to tell, from clinical and other investigations, the exact type of operation that would be most suitable in a particular case.

In short, this monograph seeks to establish the fundamental causes of the dynamic instability of the shoulder joint which make the primary episode, whether traumatic or spontaneous, liable to recur.

In this monograph (1) recurrent anterior dislocation (traumatic), (2) spontaneous recurrent anterior dislocation, (3) voluntary recurrent anterior dislocation and (4) habitual anterior dislocation (primary and secondary) of the shoulder have been etiologically differentiated. Dislocation of the shoulder joint due to violence is accompanied by pain and loss of function and requires reduction under anesthesia. In a few cases of this kind of shoulder dislocation, unlike cases of dislocation of other joints (except the patello-femoral and the temporomandibular joints), after the usual immobilization and rehabilitation, there may be recurrence with little or no trauma. This is known as recurrent anterior dislocation (traumatic). This is due to latent dynamic instability. Stable joints do not have recurrent dislocation.

The spontaneous variety has a history of primary episode caused by some ordinary activity, though one often involving some strain, as for example making a stroke in golf, serving a ball in a game of tennis or volley ball, or simply putting one's arm in a jacket sleeve, reaching for a window latch situated at a lower level than oneself while lying on one's back, or doing the breast stroke in swimming. This variety is also associated with pain and requires reduction by a surgeon. This kind of dislocation becomes more facile and less painful with subsequent episodes, and in some cases the patient can even reduce the dislocation himself. This is due to the manifest dynamic instability of the joint.

In case of voluntary recurrent anterior dislocation, the history of the first episode cannot be elicited. When the patient reports to the doctor the disorder is found to have reached a stage at which the dislocation can be induced at will by positioning and contracting a certain group of muscles, and reduced by the patient himself without any pain. The above 3 types usually occur in the age group of the late teens and early twenties.

Habitual dislocation occurs with every movement involving abduction and extension of the shoulder and is painless. It may also assume the form of permanent anterior dislocation which is usually found in children and is due to hypoplasia of the glenoid or its labrum and consequent elongation of the anterior capsule. This may also be due to postpolio paralysis of the shoulder, in which case it is known as primary paralytic habitual dislocation. In a few cases of the latter type, dislocation may recur after a lapse of varying periods of time after rehabilitation by multiple muscle transfer. This is known as secondary habitual anterior dislocation.

The author stresses that the pathological changes found in the joint are rather the effects of the violence of inital episodes and not the causes of recurrence. It is significant that joints having a history of mild trauma, or none, may not show any anatomicopathological changes. An attempt is made to rationalize Eden-Hybinette, Bankart, Putti-Platt and Magnuson-Stack operations currently practiced as standard procedures for the treatment of recurrent anterior dislocations of the shoulder in different parts of the world.

Though chapters on the outlines of the classical predisposing factors, mechanism, anatomicopathological lesion and treatment have been included in this monograph, the author does not pretend to give an exhaustive account of the evolution of these topics. Readers interested in the subject may consult two admirable monographs, namely, von Hellens' "Über die habituelle Schulterluxation" (1947) and Moseley's "Recurrent Dislocation of the Shoulder" (1961). For a fuller appreciation of the shoulder joint mechanism the reader may refer to the author's monographs "Theory of shoulder mechanism: descriptive and applied" (1961) and "Surgery of paralysed and flail shoulder," Supplement 97, Acta Orth. Scand. (1967). Of the numerous references, nearly 1400 in number, only those have been selected which have some connection with history, etiology and methods of treatment.

Present Position of Knowledge of Recurrent Anterior Dislocation

Predisposing Factors

Young age and epilepsy are generally recognized as predisposing factors responsible for the recurrent anterior dislocation of the shoulder. The significance of the duration of immobilization after reduction of the first episode in relation to subsequent recurrence is far from being proved. Opinions differ. Hobart (1939) and Pettersson (1942) proved by arthrography that a longer period of immobilization would prevent the recurrence. On the other hand, in the Mairbaux (1913) series of 157 follow-up cases of traumatic dislocation, there was not a single case of recurrence in spite of early mobilization. Again, the type and duration of immobilization did not affect the incidence of recurrence in 488 cases (Rowe 1956).

On age predisposition Hermodsson (1934) writes that it is remarkable that the traumatic dislocation which later recurs has quite a different predisposing age. The cause of this must lie either in the way the dislocation occurs or in an anatomical difference in the shoulder joint. But since a difference in the way dislocation occurs cannot be found, that means that there must be a difference between the shoulder joints in which the 2 types of dislocation are found. It must equally mean that those shoulder joints which succumb later on to recurrent dislocation must show a predisposing anatomical abnormality. He failed to identify any predisposing abnormality of the joint. In a series of 488 cases (500 dislocations) recurrence in the second decade was 92% (Rowe 1956).

Other causes of recurrences are the following:

1) Anatomical abnormalities: Congenital aplasia and flattening of the glenoid (Böhler 1912), congenital ill-developed loose capsule and labrum (Volkmann 1882), Putti-Platt 1960) and congenital humerus varus (Matolay 1939, Bazy 1918, Oudard 1926, Gregoire 1913, Goldthwaite 1909).

2) Muscular incoordination due either to weakness or paralysis (Clairmont and Ehrlich 1909, Saha 1961).

3) Abnormal shortness of pectoralis major and latissimus dorsi (Young 1913, Sever 1921, Hofmann 1924, Sacepin 1938).

From the above it may be said that the inherent peculiarity of a joint, when fully developed (i. e., about the age of 18 to 21 years), is the only common predisposing factor besides epilepsy in an otherwise normal young adult. Other congenital anomalies in capsule and bone would cause much earlier incidence. Recurrent dislocation of the shoulder joint is generally compared with inflammation. The predisposing factors of recurrent dislocation, like the causes of inflammation, are many.

Mechanism of Recurrent Anterior Dislocation

The first episode of a recurrent dislocation of the shoulder may not be caused by trauma in every case. In a case arising from a fall on an abducted limb and uncomplicated by forces from other directions, the head of the humerus dislocates through a tear in the

inferior part of the capsule. Treatment with adequate rest after reduction prevents recurrence of the dislocation. The mechanism and the type of tear in the capsule preclude recurrence.

In cases complicated by a forward push, either direct or indirect at the back of the shoulder of an abducted arm, the humeral head dislocates (1) through a rent in the anterior capsule, (2) through a rent between the labrum and the anterior hemiring of the glenoid, (3) in a pocket of raised periosteum from the neck of scapula anteriorly in continuity with the glenoid labrum and capsule and (4) in a pocket of the stretched lax capsule without producing any rent. An indirect push may result from a fall on the outstretched limb with the shoulder in extension. Once the limb is fixed to the ground by the palm or the point of elbow, the limb in its futile attempt to prevent the torso from falling goes into further extension at the shoulder joint creating a condition favorable for dislocation. The capsular rent would heal with adequate rest after reduction. The labrum detachment heals imperfectly and in the last group the question of healing obviously does not arise.

In the first 3, there is usually soreness of the shoulder for a considerable time even after reduction. With a lax capsule, there is practically no soreness once it is reduced. After a couple of days, the patient can move his affected limb as well as the sound one.

There is yet another type, quite common, which does not show any history of fall. In this type the first episode occurs usually during the late teens and early twenties. It can occur while putting the hand in the sleeve of a coat; swimming breaststroke or overarm stroke; bowling in cricket; attempting a smash in tennis, badminton, or volley ball; or just throwing stones. Even a little jerk felt while holding the overhead bar when a crowded bus stops suddenly can cause it. In every instance in this group it is obvious that the shoulder joint undergoes extension and abduction. These cases always recur and are termed spontaneous recurrent dislocations. Since there is no injury, there is no tear in the capsule. In these instances the head of the humerus is put back in place some times by the patient himself. Rowe (1956) had 4.4% of spontaneous dislocation in his series of 500 luxations.

The foregoing discussion obviously brings in the subject of inherent instability in some shoulder joints. Dislocation in a perfectly stable joint requires trauma, and in some cases, this may produce a compression fracture of the head in the posterosuperior sector, a fracture of the tuberosity and/or a fracture of the anterior rim of the glenoid and labrum detachment. An unstable joint does not require any trauma for the first or subsequent episodes. The joint may, however, show secondary changes as a result of repeated dislocations.

Anatomicopathological Lesions

Investigations carried out in cadavers, during operations and radiographic observations have been the accepted methods between 1880 and 1946. The majority of investigations have tried to explain the recurrence of the dislocation on the basis of their respective findings. Chief findings were the following:

1) Rupture of the capsule (Perthes 1906, Hybinette 1932, Langenskjøld 1939, Pettersson 1942). Pettersson found ruptures in his series of 31 cases. Rupture occurs in the anterior part, although at different levels, perhaps depending on the degree of abduction (Hybinette 1932). The tear may affect a part of the periosteum on the anterior aspect of the neck of the scapula (Langenskjøld 1939). In these cases the dislocations are termed intracapsular.

2) The tear of the musculotendinous cuff was found and proved by Lindblom in 1939, Axen in 1941, and Pettersson in 1942. In Pettersson's series the ratio is 4:31.

3) Changes in the bony and cartilaginous rim of the joint socket: In some cases the glenoid labrum is detached for a variable length from the anterior margin. The anterior brim of the socket may be injured, and the bony rim is rarely fractured. Among the researchers who found the cartilage detachment more or less constant during their operations on the recurrent dislocation of the shoulder are Eden (1918), Henderson (1918), Hybinette (1932), Bankart (1938), Gray (1939), as well as Bost and Inman (1942). Bankart and Gray energetically asserted that the lesion was present in every case of recurrent shoulder dislocation. It may be mentioned that, in normal cadavers, the glenoid labrum may not be attached to the bone for a varying segment (Broca and Hartmann 1890, Schüller 1890, Fick 1904, Davies and Davies 1962). Repeated dislocations bring about attenuation, fibrillation, transverse and longitudinal fissures, and scars in the labrum, whether attached or detached.

Changes in the anterior bony glenoid margin include fracture, osteochondritis, attenuation, fibrillation, detachment of the articular cartilage, and calcification. There may be loose bodies, either osseous or osseocartilaginous, as a result of injury. The findings thus described are either caused during the first episode as a result of trauma or subsequently from repeated slips following minor injury.

4) Changes in the upper end of the humerus: A sickle-shaped depression in the posterosuperior sector of the head of the humerus may be found in some cases. The depression may be mild, moderate, or severe. Roentgenography in special positions may be necessary to identify this. First demonstrated by Flower (1861), the detailed radiologic technique was worked out by Pilz in 1925. The incidence of this sickle-shaped depression varies from 20% to 100% (Schultze 1914, Bazy 1918, Pilz 1925, Hermodsson 1934, Boicev 1938, Pettersson 1942, Hill and Sachs 1940, Rowe 1956) with different observers, the latter figure being applicable exclusively to traumatic cases. The lesion as the *only cause* of recurrent dislocation was proposed by a few of the researchers. The fracture of the greater tuberosity may be present. This, of course, is the result of the first episode following a fall.

From the foregoing observations about the predisposition mechanism and anatomicopathological lesions found in established cases of recurrent anterior dislocation it can be seen that attempts have been made to ascribe or identify it some of the time with a predisposing factor and sometimes with a pathologic lesion.

Von Hellens (1947) in his monograph on the probability of a single cause said that it might be left to the decision of future investigators.

Treatment

It has been universally accepted that the open operation is the only sure way of obtaining a cure for recurrent anterior dislocation of the shoulder while retaining its function. Treatment of the crippling condition may be found adumbrated in the writing of Hippocrates. (460 B. C.). Scarring by cauterization of the tissues in front of the shoulder joint with a red-hot iron introduced through the axilla, as advocated by Hippocrates, is still the basis of some of the modern methods.

Magnuson and Stack (1943) were able to collect from medical literature over 250 different operative procedures, or their modifications, for the treatment of recurrent anterior dislocation of the shoulder. The very number of the methods proves that none of the

procedures has been acknowledged to be foolproof, Kirschner's (1913) aphorism, "Operative treatment knows many methods which show success, but no method is known which prevents recurrence," holds good even today.

The operation advocated by surgeons may be divided into two major groups:

1) Methods based on the treatment of either one of the predisposing factors or correction of the abnormal anatomy which is considered to be the cause of recurrent dislocation

2) Methods that deal with the condition empirically on the basis of clinical disability.

It will be seen that in their zeal for recommending their procedures, surgeons were often more keen on establishing their ideas than on finding an exact solution to the problem.

Under the first group Bardenheuer (1886), Krönlein (1882), Gerster (1883), Ricard and Verneuil (1894) should be given credit for developing the operation of capsulorrhaphy, with or without opening the joint, and that of partial resection of the capsule. Ropke (1912) shortened the subscapularis tendon in addition to shortening the capsule. Many modifications of this technique of shortening the anterior part of the capsule have since been developed. They are based on the idea of capsular laxity as the cause of recurrent dislocation. In some cases reinforcement is provided with fascia lata or a strip of periosteum.

On the basis of the findings of Perthes (1906), namely, the avulsion of the muscles inserted in the greater tuberosity and detachment of the labrum from its attachment with the glenoid, quite a number of operations came into being. In this connection the names Worcester (1920), Bankart (1923), Logen (1926), Moulinguette (1931), Matti (1936), Gray (1939), Bost and Inman (1942), Sirito (1942), and Magnuson and Stack (1943) may be mentioned.

Bankart and Gray worked from the concept that the detachment of the glenoid labrum is the only cause of recurrent dislocation; Putti-Platt and Magnuson and Stack worked on the basis of an earlier concept of Ropke and Matti (detachment and/or elongation of subscapularis tendon); from these they devised operations which have subsequently been practized in America and the Commonwealth countries. Bankart (1938), while advocating his method, remarked that the operative treatment was based on erroneous ideas of the pathology of recurrent dislocation, that the cause was ignored, and that treatment was done empirically on clinical conditions.

Muscular imbalance as a predisposing factor of recurrent dislocation led Clairmont and Ehrlich (1909) to produce a muscular antimechanism which would hold the head of the humerus in the joint socket and thus counteract the forces which dislocates the head. The names of Finsterer (1917), Ollerenshaw (1920), Clairmont (1936), and Palmen (1917) may be mentioned in this connection.

In the belief that the shortening of the latissimus dorsi and the pectoralis major is the cause of recurrent dislocation, Henderson (1918) and Hofmann (1978) tenotomized the tendon of the latissimus dorsi. Sever (1921) severed the tendon of the pectoralis major. Sacepin (1926) elongated the tendon of the latissimus dorsi. Bülow and Hansen (1932) sutured the tendons of the pectoralis major, latissimus dorsi and teres major to the greater tuberosity after detachment of the subscapularis tendon.

The story of bone operations is equally interesting. Hildebrand (1902) obtained a better anterior support by scooping the joint socket with a sharp spoon posteriorly. Meyer-Burgdorff (1933) did posterior wedge osteotomy of the neck of the scapula to make the anterior margin more prominent. Bressot (1933) osteotomized the neck of the humerus in the belief that the congenital humerus varus was responsible for the recurrence. His idea was to give a valgus tilt to the upper end of the humerus.

Hybinette (1932), on opening the shoulder joint of a case of recurrent anterior dislocation, noticed the disappearance of the glenoid labrum and flattening with attenuation of the anterior margin of the glenoid cavity. He and Eden (1918) independently tried to correct

this by putting a bone graft in front of the glenoid. This operation also has quite a number of modifications.

The raising of the anterior margin of the glenoid with the help of a vitallium prosthesis was introduced by Moseley (1947).

Oudard (1925) created an extracapsular obstacle with the help of a coracoid osteotomy which would prevent the dislocation of the head of the humerus. This also has a number of modifications.

The second group of operations, based entirely on clinical examination, suspends the head of the humerus in some way or other close to the joint cavity so that during the movement of the shoulder it would not lose its contact with the joint socket. The operations are either done intra- or extracapsulary, often with fascia, but also with tendons either commissioned locally or from a distance.

Kirschner (1914), Joseph (1917), Schmieden (1919), Loeffler (1920), Herfahrt (1922), Henderson (1926), Carrel (1927), Gallie (1927) and Kapel (1939) have each described methods of suspension either of the head of the humerus or of its greater tuberosity with the help of fascia and/or tendon to the acromion or coracoid process. Rupp (1926), Heymanowitsch (1927), Purckhauer (1928), Nicola (1929), Legal (1931), Wahl (1931), Roberts (1933), Weinstein (1934), Frejka (1935), Sapiro (1935), Grigozev (1938), Bush (1945), and Chamitz (1945) did the tenodesis with the help of the long head of the biceps, the technique being a little different with each.

Till 1955 the author treated all his cases of recurrent dislocation of the shoulder by the Bankart's procedure. In a few he used stapling as advocated by South African surgeons. In half of his cases he could not detect the detachment of the glenoid labrum. In some he noticed the findings described by Hybinette. The results have been satisfactory in so far as recurrence is concerned, though restoration of function, even with the best results from the point of view of recurrence, was far from the desired maximum. Regarding other operations he had no experience and had, therefore, to rely on data offered by von Hellens (1947) in his monumental monograph.

Assessment of Dynamic Stability: Essential Determinants

Structural Determinants

State of Development of the shoulder joint; Vertical and Transverse glenohumeral indices

The humeral articular surface is about three times that of the glenoid in a fully-formed joint. This was worked out by anatomists in the cadaver. In the hypoplastic glenoid this ratio may be different. Less contact than normal of mutual articular surfaces would make the joint vulnerable even during normal movements. There is no work that has come to notice by which we could determine the state of development of the articular surfaces of the shoulder joint in the living. Obviously, we have to rely on radiological findings, and there should be some criteria by which one could say that the joint is fully developed. The problem of the hypoplastic glenoid in recurrent dislocation of the shoulder joint is different from that of a fully-formed joint.

Stereoscopic examination of the shoulder joint cannot solve the problem as precise measurements are not possible. Roentgenograms of the shoulder joint in the same position, at right angles to each other, give two-dimensional contours of the reciprocal joint surfaces. The humeral articular surface, being convex, is sharp in outline. It can be measured with the help of a planimeter in both the views. The articular surface of the glenoid, being concave and tilted in two planes, throws on the anteroposterior x-ray a double converging outline and that in the axial view, a triangle with its base directed cranially. Therefore, the curve defies accurate measurement. In these circumstances, we have to fall back upon the anthropological methods of determining the glenohumeral index using the maximum chords (diameters) of the joint surfaces measured in two views, thus:

$$\text{Glenohumeral Index} = \frac{\text{maximum diameter of the glenoid}}{\text{maximum diameter of head of the humerus}} \times 100$$

The respective indices in anteroposterior and axial views are termed vertical and transverse indices.

The anthropological glenohumeral indices in macerated joints were determined in 60 paired specimens by Ray and Bose of the Anthropology Department of Calcutta University. The specimens were taken from the anatomy departments of different colleges. The longitudinal glenohumeral index was found to be 77.8 (minimum 65.5 and maximum 95.5). The transverse glenohumeral index was 65.0 (minimum 51.5 and maximum 83.7). In arriving at the mean, the maximum number of close distribution was taken into consideration, the extremes being left out.

Method in the Living

Straight roentgenograms of the shoulder are taken in anteroposterior and axial view. The limb is placed in the scapular plane at 120° abduction and in neutral rotation before the views are taken. From the same axial view we can also determine the glenoid tilt and thus avoid repetition. The upper and the lower points of the articular surface of the humerus and those of the glenoid are identified in the roentgenograms. In the axial view these points

correspond to the anterior and posterior limits of the articular surfaces. The points are joined and the lengths between are measured with the help of a caliper. The respective vertical and anteroposterior numbers are tabulated and the indices are worked out using the above formula.

The vertical and transverse glenohumeral indices were worked out from 50 normal adult shoulder joints mostly drawn from the patients and staff of the N.R.S. Medical College Hospital (Sarkar), Calcutta. Of these, 34 were found to have a close distribution. The remaining 16 were scattered on either side. The mean value for vertical index was 75.3 and that for transverse 57.6. The standard deviations were ± 3.9 for vertical and ± 5.6 for transverse glenohumeral indices. If we include the extreme values, the vertical index should be 75.3 ± 7.8 and the transverse 57.6 ± 11.2. The data compare closely with the anthropological data.

There is still scope for determination of the projection errors from a larger series of cases. Mangification error is eliminated as the ratio instead of individual values is considered.

Glenoid Tilt

Definition

The axis of the scapula, i. e., the junction of the spine with the body, extends from its vertebral border to the scapular notch. The glenoid cavity is tilted with reference to the axis of the scapula in the coronal (vertical tilt) and in the horizontal planes (anteroposterior tilt). The degree and type of the anteroposterior tilt govern the stability of the shoulder joint. If, when viewed from above, the plane passing through the rim of the glenoid is at right angle to the axis of the scapula, the tilt is assumed to be "zero". The inclination of the glenoid, either dorsal or ventral to the axis, determines the amount of retrotilt or antetilt, respectively (Fig 1).

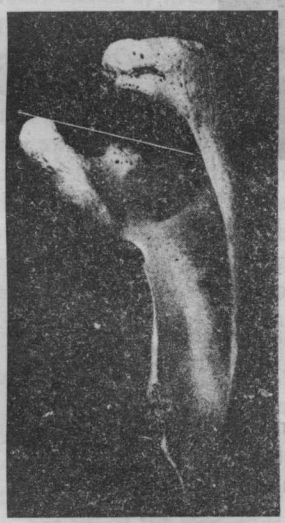

Fig 1 Bird's eye view of the human scapula showing the retrotilt of the glenoid.

First noticed by the author in 1964 and reported by Das, Ray and Saha in 1966, the glenoid tilt, which in a majority of men is directed posteriorly, has been proved to be statistically significant from random studies of 102 macerated scapulae by Das and Ray in the Anthrology Department of Calcutta University with the help of the Martin

gonometer. The retrotilt was present in 62 cases and varied from 2° to 12°, the largest among these (45) having a reading above 4°. The remaining 40 had an anterior tilt ranging from 2° to 11°.

Morphology

In arboreal primates, owing to the increased retrotorsion of the upper humerus and the consequent instability, we notice the evolutionary trend of the glenoid tilt. In siman types such as the langur, loris, baboon and common gibbon, the retrotilt is very marked (Figs 2 and 3). The necessity of the tilt becomes apparent when their habit of climbing trees and hanging by their arms is recalled. This is one of nature's checks against dislocation resulting from critical condition of the shoulder joint during abduction. They cannot afford to have dislocation every time they try to jump from one tree to another with their elevated arms at various angles.

Fig 2

Fig 3

Figs 2 and 3 Gibbon's scapula as seen from above and below. In both the views obvious retrotilt of the glenoid is present.

Determination by anthropometry in the Skeleton

The scapula is fixed on an osteophore with the help of a horizontal needle so that the three points mentioned below lie in the same horizontal plane and are parallel to the osteophore:

1) the point of the inferior angle of the scapula

2) the midpoint of the transverse glenoid diameter (i. e., maximum diameter taken from the most anterior to the posterior point of the glenoid margin)

3) a point where the prolonged free dorsal edge of the spine intersects the vertebral border (base of the spine)

Measurement aims at finding the tilt of the glenoid cavity with reference to this plane. The two points of Martin's static goniometer (Martin 1928) are made to touch at the 2 ends of the maximum transverse glenoid diameter. In this position the reading of the angle

is obtained directly from the protractor attached to the static goniometer. Figure 4 illustrates a scapula fixed to a retort stand on an osteophore. To make the osteophore horizontal a spirit level is used. The horizontal needle fixes the 3 points to make the infraglenoid portion of the scapula horizontal. The 2 pins of the Martin goniometer touch the midpoints of the anterior and posterior rims of the glenoid. The tilt is read directly from the protractor.

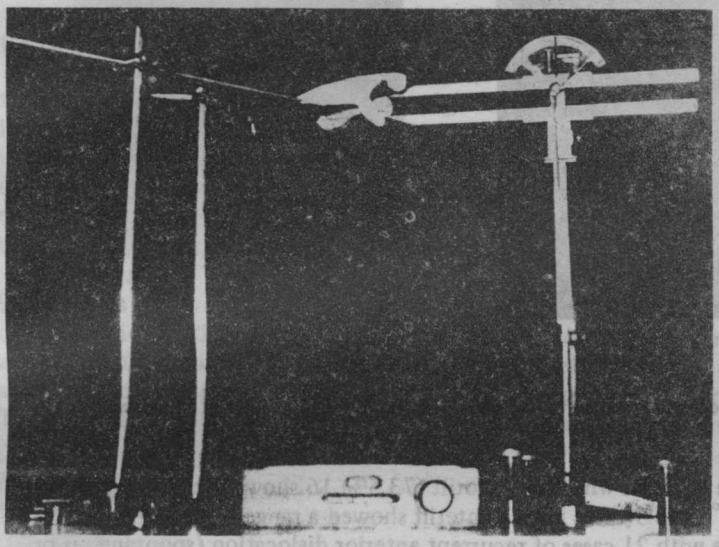

Fig 4 Illustrates a scapula fixed to a retort stand on an osteophore to determine glenoid tilt with the help of a Martin's goniometer.

Determination by Radiography in the Living – Antero posterior Tilt

The tilt of the glenoid in the living is estimated with the help of an axial roentgenogram giving a bird's-eye view of the scapula. The limb is raised to 120° in neutral rotation in the scapular plane. A cassette, preferably curved, is placed at the top of the scapula and the tube is so placed below the axilla that the rays pass at right angles to the cassette. In a true axial view a long-stemmed needle, when passed at an angle through the posterior axillary border so as to be parallel to, and in contact with, the dorsal surface of the infraglenoid portion of the blade of the scapula so as to make its tip touch the point of attachment of the spine with the body, should show only its butt end. A foreshortened appearance of the needle signifies that the rays are not parallel to the infragneloid portion of the scapula. Readings from such a faulty roentgenogram are discarded.

The axial view of the scapula, when properly taken, shows the axis of the scapula as a line superimposed on edge-on-view of the infraglenoid portion of the blade. The glenoid appears triangular in outline, depending on the tilt of the scapula in the coronal plane.

A line joining its most anterior and posterior bony points (base of the triangle) gives the maximum transverse diameter of the glenoid. The axis of the scapula is drawn on the roentgenogram by joining the midpoint of this line and the junction of the base of the spine with the vertebral border.

The tilt of the glenoid is determined from the angle which is formed by the maximum glenoid diameter with the axis of the scapula. With retrotilt the posterior angle is less than 90°. The difference between this angle and 90° gives the degree of posterior inclination of the glenoid (Figs 5 and 6).

A random study of 34 men chosen from among the students and staff of N.R.S. Medical College Hospital, Calcutta, showed that 25 had retrotilt and the remainder had antetilt of