Angular kyphosis as an indicator of the prevalence of Pott's disease in Transkei

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To understand better the prevalence, distribution and major causes of sagittal spinal deformity in a rural homeland, the authors conducted a study of angular kyphosis in the spines of 2 329 Transkei patients. Thirty-one (1,33%) had angular kyphosis. Lateral chest radiographs were obtained from 22 of these patients. Radiographic kyphotic angles ranged from 28° to 130° (mean: 70,3 ± 7,6). The vast majority (81%) demonstrated classical clinical and/or radiographic findings of tuberculous aetiology. Less frequent aetiologies included fractures (2), osteoporosis (1), congenital malformation (1) and kyphosis of unknown origin (2). Eleven of the kyphotic patients were seeking care for unrelated problems and were asymptomatic in respect of their kyphoses. As a subset, the asymptomatic individuals demonstrated a similar aetiological distribution, with 73% strongly suggestive of tuberculous aetiology. The prevalence of asymptomatic angular kyphosis in this unselected Transkei patient population was 0,47% ± 0,14%. In this hospital-based study, angular kyphosis proved a valuable marker for spinal tuberculosis. Because tuberculous spondylitis is more successfully treated when detected early, spinal palpation should be included in the routine physical examination of patients or populations at risk for tuberculosis.

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Kyphosis is defined as any increased sagittal spinal curvature with anterior concavity. It can be classified as 'rounded' or 'angular'. Rounded kyphosis is common and includes physiological, osteoporotic, postural and Scheuermann's kyphoses. Angular kyphosis, in contrast, is characterised by an abrupt increase in the dorsal angulation of the spine within the span of a few vertebrae. Angular

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kyphosis results from focal collapse or malformation of vertebral bodies in a limited segment of the spine. This deformity is often subtle and hard to detect except by direct palpation. Angular kyphoses are clinically apparent because they are usually accompanied by a palpable 'gibbus', a prominent spinous process at the posterior apex of the kyphosis. Fractures and tuberculous spondylitis, also called 'Pott's disease', are the most common causes of angular kyphosis worldwide, but tuberculosis has nearly disappeared as a cause in developed areas. We conducted a hospital-based study to learn more about the prevalence, distribution and causes of angular kyphosis in Transkei, a rural black homeland with a population of 3,1 million.[1]

Methods

During June and July 1991, 2 329 patients were screened for angular kyphosis at Umtata General Hospital. Patients were sequentially entered into the study from three outpatient clinic sources: orthopaedics (17%; 402), family medicine (54%; 1 254), and paediatrics (29%; 673). A subsequent review of hospital records revealed that one-third of all patients seen at the family medicine and orthopaedic clinics and all patients seen at the paediatric clinic during the investigation period had been included. The family medicine and orthopaedic physicians who chose to participate reported their assigned patients with only occasional random oversights. Patients sent to non-participating physicians accounted for the large group (two-thirds of the patient load) not included. Because patients were allocated to physicians randomly, patients were equally likely to be assigned a non-participating physician and be excluded from the study; therefore, inclusion bias was minimal.

The initial survey was a modified Gaines' examination,[2] where patients were visually and manually inspected from the side while standing comfortably erect and while bending forward. Those with a gibbus were checked for neurological deficits. Lateral and anteroposterior spinal radiographs were obtained for 22 (71%) of the 31 patients with a gibbus; however, lateral radiographs were unobtainable for 9 patients because of logistical problems unrelated to kyphotic severity or aetiology.

Measurement of the kyphotic angle

In this study we used the widely accepted Medical Research Council method[3] (modified after Konstam and Blesovsky[4]) to measure the kyphotic angle from the lateral spinal radiograph. A detailed description of this geometric procedure has been published elsewhere;[3] only a brief explanation is provided here. In this procedure, linear extensions are drawn from the unaffected superior surface of the first recognisable vertebral body cranial to the lesion and from the unaffected inferior surface of the closest recognisable vertebral body caudal to the lesion. The intersection of these extensions is reported as the radiological kyphotic angle. The kyphotic angle in this report is the supplement of the Konstam and Blesovsky angle. When measured in this manner, the kyphotic angle increases with increasing kyphosis.

Diagnostic methods

Diagnoses were based on radiography, clinical history and response to antituberculosis chemotherapy. Radiology was the principal diagnostic modality. Radiological criteria for *active* vertebral tuberculosis infection were: (*i*) typical vertebral lesions (anterior, end plate or central lysis) with accompanying disc involvement; *and* (*ii*) fusiform soft tissue swelling caused by 'cold' paraspinal abscesses (anteroposterior radiograph).

To classify a patient as having 'TB spine', the angular kyphosis had to be accompanied by at least one of the following: (*i*) radiographic evidence of active infection, as defined above; (*ii*) vertebral lesions with typical radiological findings of healed tuberculosis (spontaneous fusion) *and* a documented history of a prior isoniazid response; or (*iii*) positive biopsy at surgical spinal debridement.

We classified those patients with inactive disease and no documented tuberculosis history as having 'probable TB spine' if radiographs revealed classic tuberculous lesions. The radiological criterion for excluding metastatic disease in both the 'TB spine' and 'probable TB spine' categories was the presence of narrowed disc spaces. The clinical course and antibiotic response were used to exclude pyogenic osteomyelitis. BCG vaccinations rendered skin reactivity tests non-contributory.

Results

Sample characteristics

The mean age of the sample population was 24,3 ± 0,01 years (range: 3 days to 94 years; SD: 19,81 years); this age profile was representative of the Transkei population.[1] The 1989 female/male ratio for Transkei[1] was 1,4:1; the sample ratio was 1,24:1 (55,4% female). This proportion of women was significantly smaller than expected (Mantel-Haenszel χ^2: $P < 0,00001$).

Characteristics of patients with a clinical gibbus

Thirty-one (1,33%) had a gibbus. The mean age of the patients with a gibbus (26,4 ± 4,02 years) was 2,1 years older than the sample mean age (not significant). The average kyphotic angle among the patients for whom lateral radiographs were available was 70,3° ± 7,57° (range: 28 - 130; 22). Kyphosis was most often centred in the lower six thoracic vertebrae (64% of radiographed patients). Twenty-five (81%) of the kyphotic patients demonstrated either 'TB spine' (16) or 'probable TB spine' (9). Of the 6 non-tuberculous kyphotic patients, 2 had kyphosis of traumatic origin; a 60-year-old woman had severe senile osteoporosis, sufficiently localised to cause a gibbus; 1 had congenital kyphosis and 2 patients had kyphoses of unknown origin (Fig. 1). The female/male ratio among patients with angular kyphosis was 1,55:1, which was not a significantly higher proportion of women than was found in the sample ($P = 0,31$).

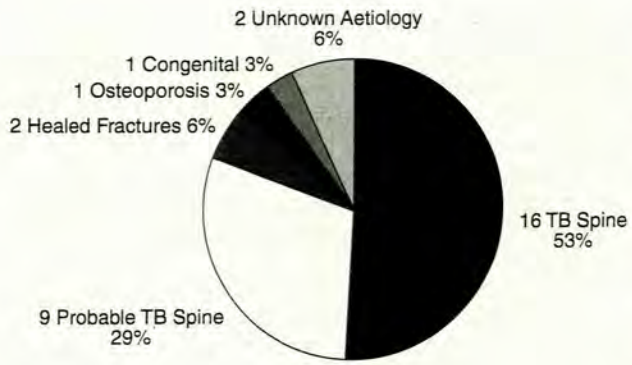

Fig. 1. Causes of angular kyphosis.

Asymptomatic kyphosis

A subset of 11 of the 31 angular kyphotic patients had asymptomatic kyphoses.These patients presented with unrelated problems. For these incidentally discovered individuals, the only obvious clinical sign or symptom suggesting tuberculous infection was the gibbus. Eight (73%) of these patients had either 'TB spine' (3) or 'probable TB spine' (5).

Statistical analysis

Extrapolation from the asymptomatic subset yields a rough estimate of asymptomatic angular kyphosis (P_{AAK}) prevalence in Transkei: P_{AAK} = 0,47% (95% CI: ±0,278%). An angle versus age linear regression was unremarkable (slope = 0,036 ± 0,36°/year; r = 0,02); however, an unexpected bimodal angle distribution appeared in the scattergram, with a gap between 52° and 90° (Fig. 2).

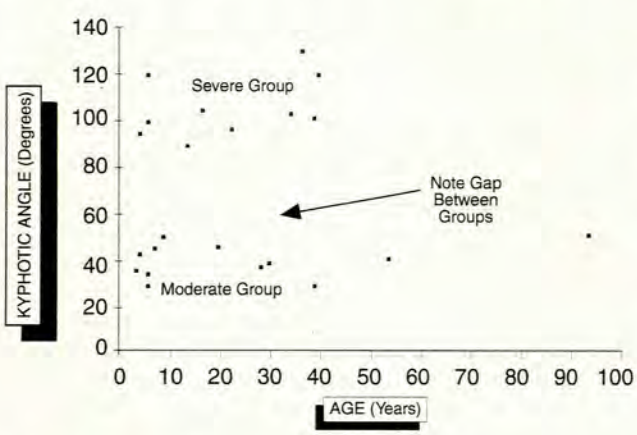

Fig. 2. Scattergram of kyphotic angle versus age.

Discussion

Kyphotic spinal disease is not new to Africa, and tuberculosis is an established cause. Egyptian mummies dating from the 4th millennium BC show signs of tuberculous vertebral infection.[5] Today, at the opposite end of the continent, spinal tuberculosis remains an important cause of kyphosis despite effective therapies. A 1972 survey of Transkei and neighbouring Ciskei reported a 10,8% prevalence of tuberculosis in males and 8,9% in females.[6] More recent prevalence figures are unavailable, but the problem is thought to have worsened. In 1989 the Transkei Health Department received 5 949 reports of new cases of tuberculosis.[7] Pulmonary tuberculosis alone accounted for 15 283 (8,5%) of the nation's 180 000 hospital admissions.[7] Of the newly reported cases of tuberculosis, 225 (4%) were for extrapulmonary infection.[7]

The deriving and verifying of data for the homelands is difficult. The incidence figures cited above understate the problem because they omit sputum-negative patients, patients diagnosed in previous years, unreported patients, undiagnosed and misdiagnosed patients, and patients who are unable or unwilling to seek allopathic care. It is an unfortunate corollary that one of tuberculosis' most feared complications, Pott's disease, was found to account for 81% of the cases of angular kyphosis in this sample.

The need to study kyphosis

It is well established that dangerous sequelae often arise from severe, untreated spinal deformities.[8-10] Despite much research into scoliotics, the scientific literature contains only occasional references to the prevalence or incidence of kyphosis, and these studies vary in their conclusions.[11,12] Bradford[11] notes a need for a better understanding of kyphosis: 'Of the deformities which may develop during childhood and adolescence, kyphosis is one of the most frequent, and also one of the most frequently neglected.' We believe this to be the first study conducted to identify and characterise *angular* kyphosis.

Angular kyphosis as a biomarker

The collective experience of numerous orthopaedic surgeons suggests that angular kyphosis in the absence of surgical intervention is a permanent deformity. It is well established that congenital kyphoses will not straighten spontaneously.[10,13-15] Fractures are similar, and although individual vertebrae heal, trauma-induced spinal angulation does not decrease without intervention. Likewise, without surgery, the kyphosis of tuberculosis will not straighten.[16-20] Given the biomechanical disadvantage of the extensor muscles in kyphotic spines, it is not surprising that spontaneous straightening fails to occur in most if not all pathological kyphoses.[21-24] Bradford[25] and Bohm *et al.*[23] have claimed that permanent correction for any type of kyphosis (except Scheuermann's disease) is possible only with surgical intervention. With only one board-certified orthopaedic surgeon in their region, medical management is the usual modality available to the 3,1 million indigenous Transkeians. Therefore, angular kyphosis in Transkei is essentially irreversible,[19,26] and it is thus useful to epidemiologists as a population marker for spinal disease. Public health officials can crudely monitor *incidence* of Pott's disease from a cross-sectional *prevalence* study of angular kyphosis. If Pott's disease is controlled, serial cross-sectional studies should reveal kyphotic individuals progressively confined to older age groups.

Age and gender distributions

If untreated pathological angulation is irreversible, and physiological kyphosis increases with age, it is reasonable to expect a positive correlation between age and kyphosis.[27] We found a small positive correlation, but of greater interest was the unanticipated absence of kyphoses of between 52° and 90°. Possibly the deformity is so unstable in this range that angulation increases rapidly. Women were slightly under-represented in the sample and over-represented in the kyphotic subset. Despite the gender disparity, risk factor analysis of our data failed to refute previous reports that Pott's disease occurs with equal frequency in both sexes.[28-31] Reliance on the obstetrics and gynaecology clinic for primary health care is the likely explanation of the sample's unexpectedly low female/male ratio.

Epidemiology

This investigation deals with the prevalence of angular kyphosis and major subsets of this condition: P_{AAK} and asymptomatic angular kyphosis attributable to tuberculosis ($P_{AAK:TB}$). For inferential purposes, only the subset of patients asymptomatic in respect of their angular kyphoses is informative. In deriving prevalence figures, assumptions are made that individuals with P_{AAK} have the same likelihood as the general Transkei population of: (*i*) contracting an 'unrelated' medical problem; and (*ii*) receiving medical care. Extrapolation suggests that Transkei's incidence of P_{AAK} is 0,47 ± 0,14%, and of $P_{AAK:TB}$ 0,34 ± 0,12%. In other words, nearly 1 in 200 people in Transkei is afflicted with P_{AAK}, and about 1 in 300 (equivalent to 10 500 Transkeians) has $P_{AAK:TB}$. Analysis of data from asymptomatic patients suggests a total population attributable risk fraction for tuberculosis of 73%.

Validity and import

The small size and the hospital-based nature of this study somewhat undermine the power of these findings, but the results are still alarming. To separate relevance from the statistically imprecise results, a 'best case' analysis is illustrative. Crudely to approximate community prevalence of angular kyphosis from this hospital-based study, the asymptomatic prevalence figures must be increased by a finite amount to account for the 20 excluded symptomatic patients (angular kyphosis patients include symptomatic and asymptomatic people). A range for Transkei's angular kyphosis prevalence is thus: 0,47% < angular kyphosis < 1,33%. If one focuses on the lowest (most conservative) estimate of 0,47% and computes the bottom of its confidence interval, one derives a maximally conservative estimate of 0,19%. Thus after accounting for all statistical imprecision, we are 95% certain that a minimum of 1 in 500 Transkeians has a gibbus, and three-fourths of these will have tuberculous aetiologies. Greater precision must await a population-based study, but these interim results may assist policy-makers in the short term.

Clinical relevance

The human spine can compensate for kyphosis remarkably well during the early stages, which may mask the diagnosis if one relies solely on visual observation. However, if patients' spines are palpated, even a small, painless external gibbus is usually obvious. Radiographic scrutiny revealed no false positives during the clinical phase of the survey. We confirmed abnormal angulation on all patients with a gibbus for whom lateral radiographs were available. Therefore, the empirical diagnostic specificity of the physical examination was 100% for confirmed but unspecified spinal defect. Actual specificity for spinal tuberculosis will decrease parallel to the local population's $P_{AAK:TB}$; however, with tuberculosis also reappearing in developed areas, many point out that the index of suspicion should be raised worldwide.[32,33]

This study lacked controls for identifying false negatives, so diagnostic sensitivity of the clinical spinal examination is unknown. However, given the insidious nature of the disease, the gibbus is probably an unreliable indicator of early Pott's disease. Notwithstanding this limitation, in certain populations, screening for angular kyphosis can be an effective, low-cost, low-technology method for initial detection of spinal disease in otherwise asymptomatic individuals. With a high incidence of a curable disease as insidious and devastating as spinal tuberculosis, early detection is a must; therefore, palpation must be part of the standard physical examination, especially for populations and patients at risk for tuberculosis, such as those of the TBVC communities or immunosuppressed individuals anywhere.

Conclusion

To eradicate any disease, we must discover means of monitoring the impact of therapeutic interventions, which is often difficult in undeveloped regions. This investigation introduces a simple, clinical screening procedure for angular kyphosis. The results highlight the lingering problem of Pott's disease in Transkei. P_{AAK} prevalence in a Transkei patient population was found to be 0,47%, which may serve as a baseline against which to measure progress in the battle against tuberculosis. Beyond its modest epidemiological value, perhaps the greatest potential clinical utility of screening for angular kyphosis is early identification of patients with spinal tuberculosis. Though subtle in its initial presentation, Pott's disease is curable in its early stages. The 15-second spinal check should help rural health care workers diagnose spinal tuberculosis earlier than in the past, and it should augment the physical examination in any region of endemic tuberculosis or for immunocompromised patients anywhere. We echo Dommisse's[34] plea to screen all children exposed to risk factors for spinal deformity. Few in the modern world are at greater risk than the children in Transkei.

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