the children all the year round (B. Symmonds, personal communication, 1962).

Vitamin D is now freely available, and dark-skinned people in temperate areas should no longer develop rickets. In our series 14 of the 16 children had a degree of skin pigmentation well above that of indigenous children.

Prolonged Milk-feeding

In the Cypriot and West Indian children prolonged feeding with cows' milk or breast milk was usual and led to gross dietary deficiency of vitamin D. There is a large variation in the vitamin content of milk. For instance, a child fed on 2 pints of cows' milk a day would receive from 3 to 45 international units of vitamin D, and on 2 pints of breast milk from 4 to 100 units (Macy *et al.*, 1953).

Prolonged breast-feeding is the accepted cultural method of feeding babies in many underdeveloped countries. Indeed, wherever infantile malnutrition is a problem, prolonged breast-feeding should be encouraged (Jelliffe and Dean, 1959), but in this country it may have disadvantages.

Unsatisfactory Welfare Clinic Attendance

It is by attending welfare clinics that the majority of children in this country obtain vitamin D supplements. For the Greek Cypriot mothers attendance at welfare clinics is often unsatisfactory because of language difficulties even in families resident in Britain for many years. Although many West Indian mothers attend welfare clinics regularly and benefit enormously, others go out to work, and their children, who are often looked after by friends or unofficial paid baby-minders, are then not seen at welfare clinics.

There is a striking difference between the age distribution of our cases and those reported by Dunnigan *et al.* (1962). Thus our eldest child was 3 years and 2 months of age, while in the Glasgow series none was below 5 years. However, the Glasgow survey investigated only 14 children below 5 years, and it is possible that a larger sample might have included children with lower vitamin-D intake. Indeed, the Glasgow authors suggest that the absence of rickets in the children under 5 years of age was due to adequate vitamin D provided by foods obtained from welfare clinics which Pakistani families attended. The age difference would probably explain the presence of knock-knees in the Glasgow series and bow-legs in ours.

There was a low incidence of dried-milk feeding among the children reported in this series. Many children in this country do not attend welfare clinics or receive vitamin-D supplements. In such children an important factor in prevention of rickets is the fortification of proprietary forms of dried cows' milk with vitamin D. Thus the regrettable reduction in popularity of breast-feeding in this country may have an unsuspected advantage. The advantages of breast-feeding, however, could still be enjoyed if vitamin-D supplements were administered.

In addition to the problem of vitamin-D deficiency there would appear to be a need for attention to general subclinical undernutrition in the children of our immigrant communities, which was suggested by the low haemoglobin levels and body weights seen in many of our cases.

Summary

All the cases of nutritional rickets seen over the last five years at Guy's and King's College Hospitals are reported. Of 16 patients, all of whom were under 4 years old, 14 originated from non-temperate areas and had a degree of skin pigmentation well above that of children from this country.

Although skin pigmentation was thought to be a major factor, nutritional deficiencies related to cultural variations were also important.

The need for attention to all aspects of nutrition in immigrant children is stressed.

We are grateful to Dr. Mary Wilmers, Mr. C. Catterall, Dr. Doyné Bell, Dr. P. R. Evans, Dr. R. C. Mac Keith, and Sir Wilfred Sheldon, under whose care most of these cases were treated. We would like to thank the department of medical illustration of King's College Hospital for Figs. 1 and 2.

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DIAGNOSIS AND TREATMENT OF SPRAINED ANKLE

BY

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The sprained ankle is probably the commonest minor traumatic condition which the casualty officer and general practitioner is called upon to treat. Often, however, the immediate pain and disability are prolonged unnecessarily, and occasionally permanent harm may result. The fault may be in misdiagnosis, a severe injury being overlooked, and consequently inadequately treated, or it may be due to unsuitable treatment when the sprain is correctly diagnosed.

It is the purpose of this paper to discuss the diagnosis of ankle sprains with particular reference to the exclusion of more serious injury, and to suggest a method of treatment which is more satisfactory than that in common use.

Diagnosis

Injury to the ankle-joint may result in simple sprain with stretching, partial rupture, or partial avulsion of a ligament from its attachment with or without a flake of bone. The joint is stable, the talus remaining firmly in the mortise. More serious injury results in complete rupture or complete avulsion of the ligaments, a fracture, or a combination of these injuries, which may result in immediate instability or give rise to instability if treatment is inappropriate.

The diagnosis of a simple sprain is therefore a matter of excluding a more extensive injury to ligaments and bone. The latter can be excluded by x-ray examination,

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and it is common practice to radiograph all injured ankles routinely in some casualty departments. Garfield (1960), however, suggests that it is possible to decide clinically in which cases this is unnecessary for determining treatment.

The exclusion of a complete tear of a ligament is more difficult. Forcible eversion of the foot rarely causes rupture of the medial ligament without associated bone

injury. In practice, therefore, it is usually a torn lateral ligament that must be excluded, and this ligament consists of three separate fasciculi (Fig. 1).

In the common inversion injury, where the foot is adducted and plantar-flexed, the strain is initially taken by the anterior talo-fibular ligament, and

FIG. 1.—Diagram of the three fasciculi of lateral ligament of ankle.

the calcaneo-fibular fasciculus is stressed only if the foot is adducted in the neutral position or after rupture of the anterior fasciculus (Leonard, 1954). Pennal (1943) showed that division of the anterior and middle fasciculi separately in the cadaver resulted in a slight tilting of the talus in the mortise, but only by division of both together did subluxation result.

Many writers nevertheless believe that slight tilting of the talus warrants prolonged immobilization in plaster, or open operation and suture of the anterior talo-fibular ligament (Leonard, 1954; Steele, 1955) if chronic subluxation is to be avoided (McKillop and Bianco, 1960). To detect such minor degrees of talar tilt, antero-posterior x-ray films of the ankle with the foot in forced inversion are advised, and some consider that they should be carried out routinely under general or local anaesthesia (Dziob, 1956). Leonard found complete tears of the anterior talo-fibular ligament in 23 out of 51 patients, and Steele, using such methods, found talar tilt in 33% of cases.

Rubin and Witten (1960), however, measured talar tilt in 152 normal ankles in a controlled experiment delivering constant stress, and found that over half the total had some tilt, being 10 degrees or more in 33% of the cases and sometimes as much as 20 degrees. The use of the uninjured ankle for comparison is not altogether reliable, for in 28% of patients there was a difference ranging from 3 to 19 degrees between the two sides.

Watson-Jones (1955) believes that all except minor degrees of talar tilt can be felt clinically, and, although painful, can be elicited without anaesthesia. McMurray (1955) states that inversion is quite painless with complete tears, and Coltart (1951) says that instability is due to rupture of the middle fasciculus, which is detectable clinically by tenderness below the tip of the lateral malleolus.

In the present investigation, after eliciting a brief history, the ankle was examined clinically, careful note being made of the exact site of swelling and tenderness in relation to the ligamentous attachments and bony points. The ankle was put through a full range of passive movements, and any limitation or increase in range was assessed by comparison with the normal ankle. The movements causing pain were also noted.

It would have been impracticable to take radiographs in inversion of every injured ankle under general anaesthesia, and local anaesthesia would have invalidated the results of treatment. Since minor degrees of tilt appear to be insignificant the usual antero-posterior and lateral views were taken, and inversion views, without anaesthesia, only if the affected ankle showed a greater range of inversion than the normal one or if there was tenderness over the attachments of the calcaneo-fibular ligament.

Treatment

The object of treatment is to relieve pain, promote healing, and to preserve or restore normal function, at the same time ensuring that a trivial injury does not become a severe one. Treatments proposed for ankle sprains range from "running it off" to complete immobilization in plaster. Kendall (1954) compared the effectiveness of immobilization with adhesive strapping, physiotherapy (surged faradism, effleurage, and exercises), the injection of hyaluronidase, and the injection of procaine with no treatment at all. He found there was a quicker return of normal function and more effective relief of pain after the injection of hyaluronidase, but there was no long-term follow-up to determine whether lack of immobilization and the use of hyaluronidase resulted in later disabilities.

For the first three months of the present study every simple sprain was treated with adhesive strapping (*Elastoplast Technique*, 1955). For the second three months 1,500 I.U. of hyaluronidase dissolved in 5 ml. of normal saline was injected into the most tender spot on the injured ankle (not into the joint) and the latter lightly bound with a crêpe bandage. In each case the patient was advised to use the ankle within the limits of the pain and to note carefully the date on which walking first became possible without pain, and to return to the casualty department as soon thereafter as was convenient. All fractures other than "flake fractures" were referred to the fracture clinic for further supervision.

Two years later every patient who had returned for assessment after treatment was circularized and asked to report any disability arising in the treated ankle in the intervening period. Those who replied in the affirmative were asked to attend hospital for further clinical and radiographic examination.

Results

A total of 103 acutely injured ankles were seen personally in the course of six months, comprising 85 simple sprains and 18 fractures (Table I). This is not the true incidence of fractures in ankle injuries, for, whereas all the sprains presenting in the casualty department were seen by me personally, a proportion of the

TABLE I.—Incidence and Site of Sprains and Fractures Around the Ankle-joint

		Sprains				Fractures						
		Ant. Talo-Fib. Ligament	General Sprain	Calcaneo-Fib. Ligament	Medial Ligament	Tip of Malleoli	Tuberosity 5th Metatarsal	Lateral Malleolus	Lower Third Fibular	Calcaneum	Navicular	Malleoli + Diastasis
No.	69	9	4	3	3	3	4	4	2	1	1	3
%	81	10.6	4.7	3.6	—	—	—	—	—	—	—	—

fractures were referred direct to the fracture clinic: the true incidence was approximately 25%. The relative incidence of different types of sprain and fracture is shown in Table I. No unstable ankles were seen without associated fractures, and it is therefore assumed that there were no complete ligamentous tears as isolated injuries.

The patient's description of the accident was not usually helpful in arriving at an exact diagnosis, and is therefore not recorded. The objective findings, however, are recorded in Tables II and III and were fairly constant for the varying types of injury. For example, injury to the anterior talo-fibular ligament, found in 80% of sprains, gave rise to a constant picture, with localized swelling around the lateral malleolus, tenderness accurately located at either the proximal or the distal attachment of the ligament, or sometimes both (Fig. 1). Passive movements were rarely limited when carefully carried out, and there was usually pain only on plantar flexion and inversion of the foot.

As the severity of the injury increased the findings became more diffuse. In all but the most trivial fractures there was generalized swelling and tenderness, and limitation and pain on movement in all directions (Table III).

Of the 85 patients seen with sprained ankles 68 returned for assessment, 30 having been treated by adhesive strapping and 38 with hyaluronidase (Table IV). The short-term results of treatment are shown graphically in Fig. 2, where the number of patients per cent is plotted against the time interval required to become pain-free, for both strapping and hyaluronidase.

In the latter group 75% had walked without pain in three days, and all within a week, whereas in the former group 75% were still in pain after a similar interval and 33% took 10 days or more to become pain-free.

FIG. 2.—Comparison of time interval before pain-free walking in patients treated with strapping and hyaluronidase.

Approximately 70% of the patients who returned for assessment after their original treatment replied to the postal follow-up two years later (Table IV). Eleven had had symptoms referable to the injured ankle, six having

TABLE IV.—Comparison of Number of Patients Returning for Assessment and Follow-up

	Patients Treated	Patients Assessed	% Assessed	Patients Circularized	Patients Replying	% Replying	No. with Complaints	No. Associated with Treatment	% of Replies
Strapping	39	30	80	30	20	66	6	1	5
Hyaluronidase	46	38	83	38	27	71	5	1	3.7
Total	85	68	81.5	68	47	68.5	11	2	4

TABLE II.—Comparison of Physical Findings in Sprains of the Ligaments Around the Ankle-joint

	Swelling	Tenderness	Limitation of Movement	Pain on Movement
Anterior talo-fibular ligament sprains	Generalized .. 4 Lateral malleolus .. 40 Lat. mall. + ant. talo-fib. lig. 12 Ant. talo-fib. lig. .. 9 None .. 4	Ant. talo-fib. lig. (proximal attachment) .. 24 Ant. talo-fib. lig. (distal attachment) .. 25 Prox. and distal ends ant. talo-fib. lig. .. 20	All movements .. 2 Inversion .. 4 No limitation .. 63	Inversion .. 19 Plantar flexion and inver. .. 28 Plantar flexion .. 1 Dorsiflex. and inversion .. 6 Inversion and eversion .. 5 All movements .. 10
Generalized sprains	Generalized .. 2 Lateral malleolus .. 3 Lat. mall. and ant. talo-fib. lig. .. 1 Med. mall. and ant. talo-fib. lig. .. 2 None .. 1	Generalized .. 2 Med. and lat. malleolus .. 4 Med. malleolus and ant. talo-fib. lig. .. 3	All movements limited .. 3 Inversion .. 2 No limitation .. 4	Plantar flexion, and inver. .. 1 Plantar flexion, inversion and eversion .. 2 Dorsiflexion, inversion and eversion .. 1 All movements .. 5
Calcaneo-fibular ligament sprains	Lateral malleolus .. 4	Calcaneo-fib. lig. .. 2 Calcaneo-fib. lig. and lat. mall. .. 1 Calcaneo-fib. and ant. talo-fib. lig. .. 1	No limitation .. 4	Inversion .. 1 Plantar flexion and inver. .. 1 Dorsiflexion and inversion .. 1 Plantar flexion, inversion and eversion .. 1
Medial ligament sprains	Generalized .. 2 Medial malleolus .. 1	Medial malleolus .. 3	Plantar flexion and dorsiflexion .. 1 No limitation .. 2	Eversion .. 1 Inversion and eversion .. 1 All movements .. 1

TABLE III.—Comparison of Physical Findings in Some Fractures Around the Ankle-joints

	Swelling	Tenderness	Limitation of Movement	Pain on Movement
Tip of malleoli	Lateral malleolus .. 2 Medial .. 1	Lateral malleolus .. 1 Med. and lat. malleolus .. 2	None .. 3	Plant. flex. and inversion .. 1 Eversion and inversion .. 2
Tuberosity of 5th metatarsal	Generalized .. 1 Lateral malleolus .. 2 None .. 1	Tuberosity of 5th met. .. 2 Tub. 5th and lat. mall. .. 2	" .. 4	Eversion and inversion .. 1 Eversion .. 1 Plant. flex. and eversion .. 2
Lateral malleolus	Lateral malleolus .. 3 Generalized .. 1	Lateral malleolus .. 4	All .. 1 Inversion .. 1 None .. 2	Dors. flex and inversion .. 1 Plant. flex. and inversion and eversion .. 1 All .. 1
Fibular	Generalized .. 1 Lateral malleolus .. 1	Lower 3rd fibular .. 2	All .. 2	" .. 2
Calcaneum	Med. and lat. malleolus .. 1	Generalized .. 1	" .. 1	" .. 1
Navicular	Navicular .. 1	Navicular .. 1	" .. 1	" .. 1
Malleoli with diastasis	Generalized .. 3	Med. malleolus and lower 3rd fib. .. 1 Med. malleolus and lat. malleolus .. 2	" .. 3	" .. 3

been treated with strapping and five by injection, and 10 attended hospital for examination.

In three patients the complaints were in no way related to the previous injury, swelling in one case being due to varicose veins and ulceration. In another, swelling was bilateral and of cardiac origin. A third woman had pain of recent origin, which appeared to be due to tenosynovitis of the tibialis anterior tendon. Four young women complained that the ankle was liable to "turn over," particularly when wearing high-heeled shoes, but the treated ankle was no worse than the other one, and indeed was no worse than before the injury. Two had been treated with hyaluronidase and two with strapping. One young man complained that his ankle gave way for about a year after treatment, but he had had no trouble since, even when playing soccer. Another young man had no difficulty with everyday activities, but his ankle was liable to let him down when playing soccer and tennis. Both had been treated with strapping. A middle-aged postman complained of stiffness in the ankle after rest, but he was able to walk without disability. He had been treated by injection.

In no case was any abnormality detectable on clinical or radiological examination of the ankle, and in particular no subluxation or difference in range of movement when compared with the opposite side.

Conclusions

Judging from this series there is approximately a three-to-one chance that injury to an ankle will result in a sprain rather than a fracture, and four out of five sprains will be injuries to the anterior talo-fibular ligament. It must be remembered, however, that these patients were seen at a hospital in central London, and that in centres serving, for example, a heavy industrial community the incidence of fractures might be higher.

The small number of fractures in this series precludes any conclusions being drawn on the incidence of the different types of fracture around the ankle-joint. Comparison of the physical findings in the sprains and fractures may perhaps be criticized on the same account. However, the precise localization of the tenderness to a ligamentous attachment, the absence of generalized swelling, a full range of movement, and pain accompanying only movements stressing the damaged ligament in the large number of sprains seem to be quite characteristic. The picture of an anterior talo-fibular ligament sprain is so definite and constant that a positive diagnosis can be made and radiography is unnecessary for determining treatment.

When the tenderness is not so localized, when swelling becomes generalized and movements become limited and painful in more than one direction, a significant injury to bone is more likely and x-ray examination essential.

Generalized sprains of the ankle ligaments and sprains of the medial and calcaneo-fibular ligaments comprise less than 20% of the total. Although clinical examination might suggest such a sprain, the less definite clinical picture and the relative infrequency of these injuries make x-ray examination desirable.

Complete rupture of the ligaments giving rise to instability would appear to be uncommon. In four cases, recorded as sprains of the calcaneo-fibular ligament (Tables I and II), x-ray films were taken in

inversion and in none was there a significant amount of talar tilt. If minor degrees of talar tilt indicate the need for operation or prolonged immobilization, or if complete lateral ligament tears were undiagnosed, several subluxating ankles would have been expected at follow-up, but there were none. The absence of a single complete tear in this series possibly underestimates their overall frequency, but routine inversion radiographs, with or without anaesthesia, would not appear to be justified. If the severity of the physical signs suggests a fracture rather than a sprain and no bony injury is found on the usual x-ray films, then stress films are probably indicated.

A comparison of the two forms of treatment confirms Kendall's (1954) results. The injection of hyaluronidase in normal saline resulted in pain-free walking, in three-quarters of those treated, in less than half the time taken for a similar proportion of patients treated with strapping. This does not mean that strenuous activity would be painless or that no abnormality would be found on clinical examination. It means that the large majority of patients could return to everyday activity without pain, twice as quickly.

One man attended with a sprain of one ankle during the first part of the trial and with the other during the second part, and was quite definite in his preference for the "injection treatment."

The severity of the sprain, the time interval between injury and treatment, and the age of the patients, by unequal distribution in the two groups, might have favoured one method of treatment.

The allocation of comparable patients to each group proved to be impracticable, but the random selection of patients should have eliminated such a bias. The age distribution of the two groups is very similar (Fig. 3) and 84% of patients in one group and 83% in the other were treated within 24 hours of injury.

The follow-up brought to light 10 patients with ankle symptoms, prepared to attend hospital for further examination. In three the symptoms were clearly not

Fig. 3.—Comparison of age distribution of patients treated with strapping and hyaluronidase.

related to the original sprain. In a further four, similar symptoms had been present before the sprain, or were present in the other ankle. One patient had had symptoms for about a year after injury, but had no complaints by the time of the follow-up. The remaining two had no abnormal findings in the treated ankle, but their symptoms possibly resulted from the injury or its subsequent management. The fact that one was treated by strapping and the other by hyaluronidase is of no significance. This figure represents approximately 4% of those patients replying to the questionnaire and 3% of those treated and assessed.

The short-term advantages of treatment with hyaluronidase would not appear to be outweighed by any long-term disadvantages. There is nothing to suggest

that failure to immobilize a sprained ankle will result in any serious long-term disability.

Summary

The diagnosis and treatment of ankle sprains is discussed.

The clinical findings in 85 simple sprains and 18 fractures around the ankle are compared. The relative incidence of injury to the principal ankle ligaments is calculated, and by including all the ankle fractures seen in the hospital during the period of investigation the relative frequency of fractures and sprains in a central London casualty department is deduced.

The sprains were treated at random with adhesive strapping or by the injection of hyaluronidase in normal saline into the injured ligament. The effectiveness of the two methods of treatment in relieving pain and restoring function is compared.

The patients were followed up two years after treatment and those with complaints referable to the treated ankle were re-examined.

It was found that simple sprains accounted for approximately three-quarters of all ankle injuries and that four out of five involved only the anterior fasciculus of the lateral ligament (anterior talo-fibular ligament).

Sprains of this ligament gave rise to a definite and constant clinical picture, enabling a positive diagnosis to be made and making radiography unnecessary in excluding more serious injury.

In the absence of a positive diagnosis of an anterior talo-fibular ligament sprain alone, x-ray examination is desirable.

Complete ruptures of the ankle ligaments occurring as isolated injuries and giving rise to instability are uncommon and routine inversion radiographs with or without anaesthesia do not seem to be justified.

Treatment by injecting hyaluronidase and normal saline into the site of injury resulted in more rapid relief of pain and quicker return to normal function than the conventional treatment with adhesive strapping.

There would appear to be no long-term disadvantages of this treatment. In particular, failure to immobilize the sprain did not result in late instability.

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FAMILIAL VISUAL DEFECTS ASSOCIATED WITH POLYCYSTIC KIDNEY AND MEDULLARY SPONGE KIDNEY

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Polycystic kidneys have long been recognized as a familial condition, but the familial occurrence of pyelonephritis, glomerulonephritis, and other types of renal disease has been noted more recently (Hawkins and Smith, 1950; Perkoff *et al.*, 1951; Hilson, 1957; Robin *et al.*, 1957; Goldsmith *et al.*, 1958; Williamson, 1961). One feature of familial renal disease has been its association with other congenital anomalies such as malformations of the ear (Hilson, 1957; deafness (Alport, 1927; Williamson, 1961), multiple structural abnormalities (Hawkins and Smith, 1950), and the other defects of Marfan's syndrome (Loughridge, 1959).

Visual defects, including congenital cataracts, have been described in association with inherited renal disease in Lowe's syndrome (Lowe *et al.*, 1952; Schoen, 1959) and in familial nephritis (Sohar, 1956; Hilson, 1957; Goldbloom *et al.*, 1957). Cairns (1925) described a family in which polycystic kidneys occurred in association with severe myopia.

The family reported below in which cystic renal disease occurred in association with cataract and other visual defects provides a further link in this somewhat irregular chain. The occurrence of cystic disease of the medullary pyramids in two members of the family and polycystic kidneys in another suggests a developmental relationship between these two disorders.

The Family

The family tree is shown in Fig. 1.

Case 1 (Propositus: III 6).—A man, aged 22 at the time of death in 1960, was admitted to the Royal Melbourne Hospital complaining of nausea and vomiting for the previous five months. He had been blind from birth, and polydipsia and nocturia with occasional episodes of frequency had been present as long as he could remember. On examination pallor, bruising, coarse nystagmus, and central cataracts were noted. The blood-pressure was 150/110. He was only able to distinguish between light and darkness. There was intermittent proteinuria (0.4 g. in 24 hours) and slight glycosuria. On microscopy the urine showed six leucocytes per high-power field in the centrifuged deposit. There was no growth on culture. Excess cystine was present on the amino-acid chromatogram. The blood urea was 349 mg./100 ml., the haemoglobin 5.1 g./100 ml. and the leucocyte 15,000/c.mm. The glucose-tolerance test showed a diabetic type of curve. The electro-

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