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TINEA CAPITIS

EDWIN H. CRESSMAN
Professor of Dermatology and Syphilology

The prevalence of fungus infection of the scalp has never reached serious epidemic proportions in this country. During the past two years a sizeable epidemic has been developing in the large metropolitan areas scattered throughout the country. Some cities at the time of this writing are numbering cases above 20,000. While this is purely a local disease of the scalp and integument it does offer some serious problems in epidemiology.

Ordinarily, contagious diseases are isolated until the patient is well. This is not practical in tinea capitis since it will frequently require six to eighteen months or longer to cure this disease. Exclusion of these children from the schools for such long periods of time is certainly not advisable. In some large European cities where the disease is always prevalent isolation schools are maintained for cases of ringworm of the scalp. This plan offers many advantages. It makes possible segregation without the loss of long periods of time from school. It also makes possible proper supervision of the progress of the infection and the determination as to when cure is complete and the child noninfectious. Perhaps even more important it offers the possibility of bringing all children to one center for the mass treatment of the disease by proper methods. However, an isolation school does have certain disadvantages. It makes it necessary for some children to travel great distances to and from school, and many are too young to reach such a school unattended. The presence of the disease is so difficult to observe that for many weeks new cases attend the regular schools unrecognized. It makes no provision for complete isolation, only segregating the children during school hours.

The close contacts of children at play will infect many; but more particularly in recent years, there has arisen a new method of spread of contagion, the movies. Ringworm of the scalp almost always begins in the occipital area. A child sits back in his seat rubbing the back of his head against the back of the seat. The upholstery material is usually of such type that particles of scale and bits of hair will remain and there furnish a source of infection to many others for a long period of time. It is possible for a single contaminated seat to infect innumerable children. Fabricated leather should be used to cover theater seats. Such a smooth surface will not retain as readily particles of scale and hair and would easily wipe off. We believe this is important enough that a public health regulation should exist which would not permit the use of any other kind of material. Reif¹ believes that the movie is a more common method of transmission than the school. Certainly, infected children should not be
permitted to attend movies; but even if so directed, how many will fail to comply?

It can be seen without further discussion that epidemics once started can readily get out of hand and will prove difficult to bring under control. Proper management is so necessary, and accurate information must be available for the parents of infected children.

This is a disease of childhood; age is an important factor in susceptibility. Even among animals only the young are normally infected. Cases of ringworm of the scalp in adults are rare. Age is so important a factor in the susceptibility to this disease that spontaneous cure at the time of puberty is not uncommon.

Another interesting feature of this disease is its selection of boys rather than girls. Statistics from various sources give ratios of 3 to 1 up to 10 to 1 or even higher. Up to the present time in this epidemic very few girls have acquired the infection. We believe this is due to the short hair cut in boys enabling infectious material to reach the scalp. Short hair is probably the reason for nearly every scalp being infected in the occipital area first. The longer hair of girls is not only a protection to themselves but probably helps protect others by retaining better the infected particles.

It is important to understand that the fungi which produce these infections remain viable indefinitely on contaminated objects. They are not destroyed by any of the usual methods such as boiling or antiseptics. This is not only important in infecting others but also from the standpoint of reinfection and failure to cure the patient.

The disease is transmitted by direct contacts in play, by contaminated objects (hats, combs, brushes, etc.), by contaminated backs of upholstered chair seats particularly in public places, by dogs and cats who are infected, and by carriers—animals, children, and adults in whom clinical symptoms do not become manifest.

We do not intend in this paper to name and classify some eight or more organisms which produce tinea capitis nor to discuss their cultural characteristics. A practical classification into two groups, "zoophilic" and "anthrophilic" is useful. These terms were suggested by Wise and Sulzberger. Zoophilic infections are usually caused by the microsporum lanosum. They are common in animals and not so common in humans. And still more important, they are usually readily curable with topical applications. X-ray epilation is not necessary.

Anthrophilic tineal infections are usually caused by the microsporum audouini. This is the most prevalent form of ringworm of the scalp. It is difficult to cure and frequently will not respond to topical therapy making it necessary to resort to x-ray epilation. This infection is not common among animals.

These two organisms cause about eighty per cent of the infections. In some sections of the country microsporum lanosum is the predominant organism; in others, microsporum audouini.
TINEA CAPITIS

After contact the organism invades the epidermis, the shaft of the hair near the scalp, and the hair follicle. The cardinal symptom of a fungus infection of the scalp is a patchy loss of hair almost always beginning in the occipital area. Invaded hair becomes brittle, breaking off close to the scalp leaving dull, lusterless stubble or at times breaking off so short that only the ends of the hair in the follicles can be seen, "black dot ringworm." The patches are quite variable as to number, size, and shape.

Follicular and epidermal reaction to invasion is quite variable. Most commonly the reaction is slight with little or no redness and only a small amount of fine scale covering the areas. This is commonly referred to as "gray patch" type of ringworm. Inflammatory reaction may produce redness and swelling. This may be slight or it may be of such marked degree that a large, painful, rounded tumefaction may develop. From the follicles of such an acute reaction will exude a serous or purulent exudate. This lesion is referred to as a "kerion."

While it is impossible to determine accurately the type of invader without cultural studies, clinical differences are often noted. When a child has been infected by the zoophilic organism, microsporum lanosum, there is usually more marked inflammatory reaction and tinea kerion is common; whereas the anthropophilic, microsporum audouini, produces little or no inflammatory reaction, and a gray scaly patch is the usual finding. This organism rarely ever produces a kerion. Furthermore, differentiation may be assisted on finding a dog or a cat with the infection.

When a scalp is infected with fungi it is common to find some scattered discrete follicular pustules or crusts similar to those in impetigo. They may be in the scalp or on the back of the neck, or even on the face. The local lymphatics are enlarged in some cases dependent on the degree of inflammatory reaction. At times scattered patches of more or less typical ringworm infection will occur on the glabrous skin. Permanent alopecia is rare but can occur due to the scarring produced by an acute inflammatory reaction.

Examination of the scalp with filtered ultraviolet light (Wood’s filter*4) is frequently a diagnostic aid, but more important is its usefulness in the management of the disease. Under this illumination, infected hair and infected areas will become luminescent and glow against the dark background of normal scalp and hair. It is possible by this means to follow the progress of a case under treatment and determine more accurately that the condition has been cured. When the patient is cured and no longer remains a source of contagion, no hairs or patches will glow with this illumination. Animal and human carriers can be recognized by this means. Areas not suspected as being infected may be found. Cases can be selected for local depilation, since this method of therapy can only be successful if the disease is well localized. It should be remembered that various topical applications will glow and cause confusion. These should be thoroughly removed and not reapplied for several days previous to such examination.
There is one type of infection, caused by ectothrix organisms, which does not produce the reaction to Wood's filtered light. These organisms are zoophilic and occurring in the human are prone to produce follicular pustulation or the kerion type of lesions. The hairs which are infected are not invaded by the organism. At times an ectothrix may be recognized by direct microscopic examination of the hairs. Since the structure of the hair is not invaded, or to slight degree, the hairs do not tend to break off but they do lack their normal luster.

A useful aid in diagnosis is direct microscopic examination. Suspected hairs are carefully removed with depilation forceps. Scrapings of scale are also obtained from the patches. The material is placed on a glass slide and covered with a few drops of 20 to 30 per cent aqueous solution of potassium hydroxide. This is covered by a cover slip and pressed down. Gently heat to the point of boiling until air bubbles are driven off, but do not boil as this will cause disintegration of the material. It is not usually possible to visualize the organisms immediately. At times, good visualization is not obtained until the slide has been standing for two or three hours. Heating hastens differentiation. The tiny round "spores" can usually be seen in great number. Mycelia are more difficult to demonstrate. The hair when depilated will break off just above the bulb. Only examine the follicular portion and that part of the hair immediately above the follicle. This is the greatest area of invasion. Examination is made under low and high power with the light slightly subdued.

For the purpose of differentiating the various species of organisms producing these infections, cultural studies must be made. The technique of these procedures will be found in standard texts on dermatology and mycology. Ringworm of the scalp is readily diagnosed by any experienced observer. Cultures are not necessary for diagnosis. Their chief value lies in the selection of cases for x-ray epilation.

In the differential diagnosis, any patchy loss of hair in a child should be suspected of being ringworm. Chief confusion will arise in alopecia areata. In this disease there are similar areas of baldness, but the hair falls out rapidly and the scalp has a smooth, non-scaly appearance. The skin is normal in color or slightly pink but does not look inflammatory. Most of the hairs fall out in entirety; but scattered about the areas, particularly at the margins of the patches, may be some short stubby hairs. These short hairs may be confused with the appearance of the stubble in tinea. If closely observed it will be seen that at the point where they issue from the follicles they are very thin and just above this become normal in diameter. If there is still uncertainty, microscopic examination and examination under Wood's filtered ultraviolet light can be made.

Scaly patches may occur in eczema and seborrheic dermatitis but they do not produce the characteristic loss of hair. Pustular follicular lesions and impetigo-like crusts may occur in tinea. On careful examination typical patches of baldness will be found if the
case is due to ringworm. When such lesions occur together with itching of the scalp, examine carefully for pediculi or their nits.

We have known of several cases of kerion which have been incised, probably on the supposition that they were furuncular lesions of the scalp. This is easy to understand since these large acute inflammatory elevations with their local adenopathy do have the appearance of pyogenic lesions ripe for the knife. However, a pyogenic lesion would be covered by normal looking hair.

In the adult, patchy alopecia is almost always alopecia areata. Syphilitic alopecia has a small patchy “moth eaten” appearance. A gumma of syphilis might simulate a kerion. It should be remembered that ringworm of the scalp is a very rare disease past twenty years of age.

Management

The first step is to carefully examine the entire scalp and determine the extent of involvement. Second, examine the lesions for inflammation and degree of inflammatory activity. Extensive eruptions are more difficult to treat by topical therapy. Noninflammatory types of infection, “gray patch ringworm,” do not respond well to topical therapy without depilation. If the infection is due to microsporum audouini as determined by culture, depilation is usually necessary. However, even infections caused by this organism are sometimes cured by careful topical therapy. It is probably true that such results are only likely in these infections if sensitization to the organism develops which is indicated by a very positive trichophyton test or local inflammation. If the lesion is small in size, carefully remove all the hair with depilation forceps. This cannot be done in large lesions or extensive eruptions. If topical applicants are used, keep the hair surrounding the lesions short to make application easier.

Topical therapy is always indicated if the lesions are inflammatory, animal source of infection has been demonstrated, culture shows microsporum lanosum, or in any type of infection if the area is small enough to manually depilate. Even in the resistant types of infection it has been our practice to give the benefit of a trial with topical therapy providing it is our belief that the parents are intelligent and cooperative so that the risk of infecting others may not be too great. We modify this attitude toward the resistant infections seen during May and June since summer is an ideal time to do epilation. Epilation may also be withheld in resistant cases near the age of puberty, depending also upon other considerations such as danger to others.

A great variety of topical applicants have been recommended. It seems that one good preparation is as good as another and that failure to respond is simply an indication of a resistant infection. We usually use the following ointment, which can be called the normal strength ointment:
Hydrargyrum ammoniatum 5j
Ac. benzoici 5j
Ac. salicylici 3j
Aquaphor (Duke) qs. ad. 3iv
Sig. Rub in well as directed.

(Aquaphor is a type of cholesterinated petrolatum having excellent power of penetration by inunction, and it has the added advantage of being more readily washed off with soap and water than other ointment bases.) Every night this is rubbed in well and in the morning a quick application is made. The head should be shampooed twice weekly and always followed by reapplication of the ointment. There may be some irritation due to the ointment in a few cases. If this is not severe and remains local, continue. If it causes too much irritation, use the milder ointment for one or two weeks after which the normal strength ointment can again be tried. The mild ointment is:

Hydrargyrum ammoniatum 3j
Ac. benzoici 5j
Ac. salicylici gr.xl
Aquaphor (Duke) qs. ad. 3iv
Sig. Rub in well as directed.

After four weeks examine for improvement. Look for the growth of young normal hairs and fewer infected hairs. Examination may be made with Wood’s filtered light as a guide. Treatment may extend over a period of many months. Only the acutely inflammatory lesions get well quickly. If the condition is responding to topical therapy, x-ray epilation is withheld. It is useless to try one after another various topical applications.

Care is necessary to prevent transmission of infection to other children, spread of infection to other parts of the scalp, and reinfection from various sources of contamination after cure. Parents should be given accurate information and careful instructions. Some facts to consider are outlined below:

1. The use of ointments as topical applications, since grease tends to retain fragments of infected hair and scale, offers much in the way of protection.

2. Frequent shampooing helps to wash away infectious material.

3. The wearing of a skull cap of paper to be changed frequently and burned has been recommended. A skull cap can be made from a woman’s stocking; a piece is cut off and one end sewn together. Make a number and wash them frequently.
4. Formalin sterilization for caps, hats, combs, brushes, etc., we believe is important. We have this done once monthly and particularly at the conclusion of treatment. A small piece of cloth is moistened with full strength formalin solution. This cloth and the articles to be sterilized are wrapped up tightly in a package with many thicknesses of newspaper and left for 18 hours.

5. Play supervision is necessary. Play with other children must be restricted and observed by parents, teachers, etc. Young children must be more or less isolated. Older children who understand and will cooperate can be carefully instructed. Wrestling and other close contact play is to be avoided and skull caps, which can be covered by other caps, are worn.

6. Exclusion from school is advisable but not practical due to the long duration of the disease. If under treatment and proper care including the wearing of a skull cap and proper play supervision the risk of infecting others is minimized. Isolation schools are at times advisable.

7. No case of ringworm of the scalp should be permitted to attend the movies, skull cap or no skull cap.

8. Examine other children in the same house.

9. Examine animals as sources of contagion.

10. Infected children must not go to barber shops. Barbers should be instructed regarding the character of this disease. Frequent washing of combs, brushes, etc., with soap and water is helpful. The only adequate method of sterilization if articles are contaminated is the use of formalin in an airtight container or as described above, articles being left for 12 to 18 hours.

11. During epidemics parents should be advised to examine the heads of their children frequently, particularly in the occipital area. They should shampoo twice weekly. Small lesions discovered early are much easier to cure.

Epilation with thallium acetate is a procedure not without considerable danger from toxic effects which can even be fatal if any mistake is made in the dose. The dose must be carefully prepared according to the weight of the child. We never use this drug. Some consider as indications for its use cases among the feebleminded or the very young who will not remain still during the roentgen exposures, and resistant infections where an experienced roentgen technician is not available. The dose of thallium acetate is 8.0 mg. per kilogram of body weight. This is dissolved in a glass of water and taken as a single dose. The after treatment is the same as in x-ray epilation. This drug should never be given to adults, to children near puberty, to obese children, or to those having any illness, particularly renal.

**X-ray Epilation**

Cases are chosen for this procedure as has been outlined above. X-ray therapy has been a valuable addition to the management of this difficult problem. A single treatment is given after which the child can usually
attend school in one or two months. Properly done it will cure the majority of the resistant forms of infection and will fail in only a very few cases. The procedure requires skill, care, and patience, and should never be attempted by anyone who has not had adequate training. Young children are hard to manage since they must remain perfectly still during the exposures. The machine which is used should be accurately calibrated. There is considerable margin of safety between the epilation dose of 300r and the amount which can produce a permanent alopecia. MacKee\(^6\) states that a permanent alopecia has never been produced by 300r to the scalp.

It should be remembered that no applications should be used for two or three weeks before the treatment nor for two or three weeks after the treatment. The hair begins to loosen in about seventeen days. This time of falling hair is the most dangerous period. Daily shampoos should be given and adhesive tape used to assist in the depilation. Strips are pressed on the scalp and when pulled off will remove the loosened hair; they can be burned. The skull cap should be worn day and night. At this time an ointment is prescribed.

\begin{verbatim}
B
Hydrargyrum ammoniatum gr.xxx
Aquaphor (Duke) qs. 5ij
Sig. Rub in b.i.d.
\end{verbatim}

The patient should be carefully observed for four weeks and not discharged until no fluorescent hairs can be observed under filtered ultraviolet rays. Proper management as with topical therapy above is necessary to prevent reinfection.

In some cases where the disease is well localized it is permissible to epilate only the region of the infection. In most cases a complete treatment of the entire scalp by the method of Kienbock-Adamson is necessary. Even greater care is necessary at the time of defluvium when regional epilation is done.

The hair will start to regrow in one to three months.

The seriousness of the present epidemic of tinea capitis cannot be overemphasized. In the past this disease, because of exclusion from schools, has been one of the common causes of illiteracy in large European cities. The cost of control of large epidemics can be tremendous. Add to the cost of care over extended periods the cost of the establishment of special schools and treatment centers. For the sake of this discussion suppose we were to take a nominal figure of $1.00 per child per day for treatment and special schooling. A city having an epidemic of 20,000 cases would spend $7,300,000.00 annually. At the present time Chicago has 30,000 cases, New York, 20,000, and many other cities have reached epidemic proportions.\(^7\)

Early recognition with prompt and adequate management is most important if the momentum of this new American epidemic is to be checked.
References

THE ANATOMY AND PHYSIOLOGY OF THE BRACHIAL PLEXUS AND SHOULDER GIRDLE*

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Professor of Anatomy

The environs of the brachial plexus include a portion of the neck, the region of the shoulder girdle, the axilla, and the arm. It is in order that we consider, rather hastily, some of the more important anatomical relationships of the plexus.

The cervical region of the spine is but five inches in length, is composed of the smallest of the vertebral segments, and has a greater proportion of disc material in proportion to its length than is found in the thoracic region. Because of the presence of numerous articulations (two condyloid, or trochoid or pivot, fourteen arthrodial, and six amphiarthrodial), it is capable of greater and more varied motions than any other spinal region. Interposed between the craniospinal and cervicodorsal junctions it becomes evident that it lies between two areas of greater resistance or restraint. The curvature of the cervical region is convex anteriorly and, since it does not appear until after the child holds up its head, is a secondary curve. Normally this region of the spine is held in slight extension, the degree of which is easily increased by slight body sag. Such hyperextension tends to decrease the sizes of the intervertebral foramina in which are located the funicular portions of the spinal nerves passing to the cervical and brachial plexuses.

Extending in a longitudinal direction upon the prevertebral musculature and behind the carotid vessels and closely associated with both cervical and brachial plexuses is the cervical portion of the lateral chain ganglia of the sympathetic nerves. The superior cervical ganglion is at the level of the second and third cervical vertebrae and is connected to the upper four cervical nerves, the middle cervical ganglion is at the level of the sixth cervical vertebra and is connected to the fifth and sixth cervical nerves, while the inferior cervical ganglion lies between the transverse process of the seventh cervical vertebra and the neck of the first rib and is connected to the seventh and eighth cervical nerves. The connections and distribution of these fibers of the autonomic system must be kept in mind when considering the head, neck, and upper extremity.

The shoulder girdle is a portion of the appendicular skeleton and is composed of two bones, the clavicle and scapula. It is only at the sternoclavicular articulation that the girdle articulates with the axial skeleton; and, due to its presence, the freedom of motion permitted the upper extremity is enhanced. The clavicle acts as a prop for the shoulder and

*Delivered in Boston before the New England Osteopathic Association, April 29, 1944.
keeps it in proper relation to the trunk. It is a necessary structure in the production of abduction and complete elevation of the arm. Its sinuous curvatures afford the underlying neurovascular structures protection from injury during the assumption of downward and backward positions of the arm and shoulder girdle. Although depending upon the clavicle for its correct position, it is the scapula that provides a fossa, the glenoid cavity, for the humeral head and that, assisted by the clavicle, forms the bony arch above the shoulder joint.

The shoulder or humeroscapular articulation is not one that owes its strength to the shape of its bony parts as is the case in the elbow joint. The humeral head is large and rounded, and the glenoid cavity relatively small and shallow depending upon the glenoidal labrum to increase its depth. Regardless of its position, only one-third of the humeral head is in contact with the glenoid cavity at one time. The ligamentous structures of the shoulder joint being lax, it remains the duty of the surrounding muscles to be especially concerned with holding the osseous parts in proper relation. Deprived of the support of the surrounding musculature the humeral head would drop approximately one inch from the glenoid cavity although the capsule remained intact. It is due to those peculiarities that mobility rather than stability characterizes the shoulder joint and that rotation and abduction combined with the ability to extend the arm well above the horizontal plane are possible.

Although the capsule is generally loose and weak inferiorly, it receives some strength through the medium of the periarticular muscles of the inner cone. Posteriorly the teres minor and infraspinatus, superiorly the supraspinatus, and anteriorly the subscapularis muscles each contribute fibers that attach to the capsule. The muscles of this inner cone are inserted on the tuberosities just beyond the anatomical neck of the humerus and are thus above the level of the insertions of the muscles of the outer cone—the pectoralis major, latissimus dorsi, and teres major. The insertions of the inner cone of muscles should not be considered separate and distinct from one another but rather, as described by MacGregor, as forming a "musculo-tendinous cuff" that may be torn in dislocations of the humeral head. Such complications may seriously impair the function of the joint with disastrous effects upon the entire extremity.

The proximal portion of the tendon of the long head of the biceps brachii and its ability to slip out of the intertubercular groove of the humerus, has been the topic of frequent discussions. The proximal portion of this tendon lies inside the capsule of the shoulder joint and is attached to the supraglenoid tuberosity. It is enclosed within, and excluded from the cavity of the joint by a tubular prolongation of the synovial membrane that extends beneath the transverse humeral ligament and along the intertubercular groove to the level of the surgical neck of the humerus. The tuberosities of the bone are separated by a groove of sufficient depth to make simple escape of the tendon impossible. The transverse humeral ligament is a strong thickened band directly continuous with the capsule and firmly attached to the tuberosities between which
it bridges the upper part of the groove and tendon. Medial dislocation of the tendon has been described by White and others. It may be the result of direct violence, but examination of the associated parts, their position, and strength eliminates the condition as an uncomplicated injury.

Of the various movements of the shoulder, rotation and abduction were the last to be acquired, are often the first to be lost, and are regained with difficulty. It may be said that, generally speaking, the muscles of this region were originally developed for use in the pronograde position and that with the assumption of the orthograde position, characteristic of man, new duties have been added to them.

Elevation of the arm above the head is accomplished by a combination of humeroscapular motion and scapular rotation. To assume this position there must first of all be external rotation of the humeral head before abduction can be produced by the deltoid, the keynote of elevation of the upper extremity as Mackenzie describes it, assisted by the supraspinatus. These raise the arm to the level of the shoulder through humeroscapular motion. From this level the greater elevation is accomplished by scapular rotation produced by the serratus anterior, levator scapulae, rhomboidei major and minor, and the trapezius.

It is the brachial plexus of nerves that more than any other spinal nerve plexus, causes the physician concern. From birth until death we find it presenting problems that vary from simple irritative lesions of transitory nature to crippling paralyses and extensive neuritides. Its position, its architectural peculiarities, and the extensiveness of its distribution render it liable to injury. Its lesions may be acute or chronic in nature; they may be due to chemical, trophic, or infectious irritants, or to mechanical difficulties. Among the sources of mechanical irritations I include developmental abnormalities such as cervical ribs, and variations as seen in pre- and post-fixation of the plexus. Pressure produced by the scalenus anterior muscle, fractures, fracture-dislocation, and dislocations are frequently encountered. The applied anatomy of some of these conditions will be considered subsequently.

A clearer conception of the architectural peculiarities of the plexus can be obtained if a brief outline of the developing upper limb and its plexus is sketched. Since the origin of the upper extremity is from the fifth cervical to the first thoracic body segments it is most reasonable to find that the nerves supplying it arise from the same segments. We now see each limb segment carrying its own nerve supply. The growing limb is so placed that the extensor surface is placed uppermost with the radius and thumb directed forward or pre-axially, the ulna and fifth finger are directed backward and are referred to as being postaxial. The segmented arrangement of the extremity held in this position forms a most orderly pattern beginning with the pre-axial fifth cervical nerve at the radial border, backward to the first thoracic postaxial nerve at the ulnar border. The fifth and sixth cervical nerves, obviously pre-axial, are especially concerned with the innervation of the extensor region, the seventh cervical
is central in position and distribution in the hand, while the eighth cervical and first thoracic nerves are postaxial and are especially concerned with the innervation of the flexor surface.

The growing upper limb gradually assumes the more dependent or hanging position and is also partly rotated. During these changes the nerves have been dragged along with the result that their position and relation are somewhat altered.

The classical textbook description of the brachial plexus of necessity must start with the anterior primary divisions of the spinal nerves forming it, but let us not overlook the nerve roots or radicles which extend from the sulci of the spinal cord to the intervertebral canals or foramina where they join to form the funicular portion of the spinal nerve. In these relatively short radicular and funicular portions alone is sufficient material for an entire series of discussions, but remember these important links in the nerve pathways to and from the central nervous system. Doing so we can more readily think of a radiculitis and/or funiculitis producing symptoms referable to the distribution of the more distant parts. Soon after leaving the intervertebral canal the nerves give off the posterior primary divisions which, in general, pass to the muscles of the back and the overlying cutaneous areas. In cases of injury of a nerve distal to the posterior primary division sensation is retained in the posterior cutaneous area supplied but lost in the anterior area supplied.

It is the anterior primary divisions of the spinal nerves that form the great plexuses and, in the case of the brachial plexus, it is the fifth, sixth, seventh, and eighth cervical, and the first thoracic nerves from which the plexus is derived. In addition, fibers from the fourth cervical and second thoracic nerves contribute small filaments to the network. The brachial plexus is one of trunks and cords arranged in a series of straight lines passing obliquely across the neck to the shoulder.

To help us visualize the position of the supraclavicular portion of the plexus we may construct lines topographically extending from the cricothyroid region of the neck to a point just lateral to the middle of the clavicle then downward to the most lateral part of the anterior axillary fold with the arm and forearm in supination.

In order to gain a clear understanding of the formation of the plexus it is advantageous to divide it into several portions—first the anterior primary divisions, second the trunks, third the cords, and fourth the branches, some of which have a supraclavicular origin. The first portion, or anterior primary divisions, appear as they emerge from a laterally directed cleft formed by the scalenus anterior muscle anteriorly and the scalenus medius muscle posteriorly. To this point the nerves receive a fair amount of protection from these muscles. Immediately lateral to them the trunks are formed by the anterior primary divisions of the fifth and sixth nerves forming the upper trunk, that of the seventh nerve passing on alone as the middle trunk, and those of the eighth cervical and first thoracic nerves forming the lowest trunk. The trunks thus formed redivide to form the cords by dividing into anterior and posterior divisions.
Of these divisions all of the posterior unite to form the posterior cord, the anterior of the upper and middle trunks to form the lateral cord, while the remaining anterior division of the lowest cord forms the medial cord. The cords are named according to the relation they bear to the axillary artery which they reach by passing beneath the clavicle. In the axillary region the cords give off the infraclavicular branches. Supraclavicular branches are given off the anterior primary divisions in the neck.

It is important to remember that between the lateral border of the scalenus anterior muscle and the clavicle the plexus receives little protection. In the posterior triangle of the neck it is covered by the skin, platysma muscle, fascia, and the tendon of the omohyoid muscle. The anterior border of the trapezius forms the posterior boundary of this triangle and may be used as a landmark immediately in front of which the plexus can be palpated in most subjects.

The upper two nerves of the plexus are directed downward and lateralward. It will be recalled that the last nerves named form the lower trunk which produces a groove on the upper surface of the first rib which is sometimes deepened especially when a large branch from the second thoracic nerve enters into the formation of this cord as is seen in post-fixed plexuses.

Between the intervertebral canal, where the nerves first appear, and the trunks, a group of supraclavicular branches are given off the anterior primary divisions. A knowledge of the points of attachment of these is helpful to the physician seeking to locate a lesion in this part of the plexus. The nerve to the longus colli and scaleni, the dorsal scapular nerve to supply the levator scapulae and the rhomboidei, and the long thoracic nerve are given off close to the intervertebral canal. The suprascapular nerve to the supra- and infraspinatus muscles and the nerve to the subclavius are given off close to the point where the fifth and sixth nerves form the upper trunk. This is called Erb's point.

The upper part of the infraclavicular portion of the plexus may be referred to as the axillary section. It lies on the lateral axillary wall where its cords are grouped around the first and second parts of the axillary artery—its branches around the third part of this vessel.

As the nerves and the subclavian artery pass lateralward and leave the protection of the scalenus anterior muscle they carry with them a portion of the prevertebral layer of the cervical fascia to form the cervico-axillary and axillary neurovascular sheaths. The sheath contains the axillary artery and vein, the cords of the brachial plexus, the long thoracic nerve, and some apical lymphatic glands.

Recalling the regional description mentioned above it becomes apparent that the brachial plexus passes between two areas of marked mobility—the neck and upper extremity. Certain types of trauma are seen to involve the supraclavicular portion of the plexus. Positions that increase the angle between the head and shoulder, as for example shoulder presentation at time of birth, produce a stretching of the plexus. The degree of ten-
sion is, of course, greatest on the nerves of the upper portion which go to form the upper trunk. Actual avulsion may occur. Such injuries to this part of the plexus are referred to as Erb's palsy (Erb's birth palsy or Erb-Duchenne paralysis). The point of severance is located far enough lateral to the intervertebral foramen that the dorsal scapular and long thoracic nerves are not impaired with the result that the levator scapulae, the rhomboidei, and the serratus anterior muscles are not paralyzed. The nerves involved are those that arise close to the formation of the upper trunk at Erb's point. In the region of the shoulder and arm we find paralysis of the deltoid, supra- and infraspinatus, teres minor, coracobrachialis, and brachialis muscles. The fullness at the base of the neck is lost and the shoulder is flattened. The elbow is usually in extension, the forearm pronated and the hand directed slightly to the ulnar side.

Klumpke's paralysis is produced by stretching the lower part of the plexus. The usual history of such injury is that of a person who in falling from a height grasps an object in an effort to break the fall. The extremity and shoulder are forcefully extended above the head and the violence is expressed through the first thoracic and usually the eighth cervical nerves of the lower trunk. In such cases the intrinsic muscles of the hand are paralyzed resulting in the patient's inability to produce the finer movements required for skilled work. A typical claw hand is seen. It must be remembered that a cervical rib may produce these symptoms but in such cases we would not, as a rule, elicit a history of trauma. Breech birth with the arms extended above the head may cause this type of paralysis; but of the birth palsies, Erb's is the more common. According to Treves, the lowest trunk evidently contains the main supply of vasomotor nerves to the limb with the result that the skin is often red and swollen as a result of vasomotor paralysis.

Another source of supraclavicular injury to the plexus is the carrying of weights on the shoulder and may be found among those whose occupation calls for such use of the region. Changes in the relation or condition of the articular portions of the cervical vertebrae, decrease and/or irregularities of the intervertebral foramina are among the more common causes long recognized by the osteopathic profession.

Upon reaching the clavicular and axillary regions the cords are liable to injury resulting from fractures of the clavicle, upper portion of the humerus, and dislocation of the humeral head. The proximity of the large neurovascular bundle to the lateral axillary wall is especially important in the last two injuries named.

In the case of anterior dislocation of the humerus the contour of the regions we have considered is changed, the shoulder is flattened, the head is carried to the side of dislocation and the forearm is supinated. The deeper changes are as follows—the capsular ligament is usually torn at its weak inferior portion, the musculotendinous cuff of the inner cone muscles may be torn, the tendon of the long head of the biceps brachii becomes tense, and the axillary vessels are subjected to pressure. The
median nerve and the axillary nerve of the posterior cord are the parts of the plexus most frequently involved in this type of dislocation.

Displacement of a sclerotic axillary artery constitutes a problem that must not be overlooked when considering relations in the aged patient.

In considering the contents of the axilla generally Deaver makes the following statement. “Of the intra-axillary vessels the axillary vein is more liable to be injured than the artery as it is nearer the surface. Pressure on the axillary vein as in forward dislocation of the humerus, axillary tumors, a crutch, an axillary pad, or enlarged lymphatic glands, may cause edema of the arm and forearm.” The lymphatic glands of this region are imbedded in the considerable fat of the space and are not normally palpated. The importance of the fat should be mentioned since it gives support to the structures passing through the region. The function of the fat as supporting tissue is well illustrated by the edema of the arm that sometimes appears after it has been removed with the lymphatic glands during the course of radical mastectomy.

It is not the purpose of this paper to go into the minute description of complicated tests used to determine the condition of the nerves and muscles, but a few simple ones that may be of use to the general practitioners will be mentioned here.

Injury to the long thoracic nerve and the serratus anterior muscle produces “winged scapula” and may be tested by asking the patient to exert pressure through the extended upper extremity against the wall. Paralysis of the muscle permits the vertebral border of the scapula to assume undue prominence. The efficiency of the dorsal scapular nerve may be tested by asking the patient to forcefully elevate the shoulder. Contraction of the levator muscle and the rhomboidei should be felt. Paralysis of these muscles permits an increase in the depth of the groove between the vertebral border of the scapula and the thoracic wall. The latissimus dorsi draws the shoulder backward and is supplied by the thoracodorsal nerve and may be tested by instructing the patient to place the palmar surface of the hand posterior to the midpoint of the iliac crest while an attempt against resistance is made by the examiner to pull the arm forward through pressure on the elbow. If the muscle is paralyzed no resistance is encountered. Division of the axillary nerve produces flattening of the shoulder accompanied by inability to abduct the arm due to paralysis of the deltoid muscle. The median nerve may be tested by asking the patient to grasp your hand since it is the principal nerve supplying the flexor muscles of the forearm and hand. It has been called the “nerve of grasp.” Other evidences of median nerve paralysis are the attenuated index finger and the patient’s inability to make a fist, and to approximate the thumb and fifth finger. The ulnar nerve supplies many of the smaller muscles of the hand that are used in the finer movements of the hand so that it is easily tested by asking the patient to hold a pencil or to resist an effort to withdraw a card held between the fingers. The radial nerve
supplies the extensor muscles of the arm, forearm, and hand and their paralysis is easily recognized by wrist-drop.

In connection with the radial nerve I would like to call your attention to its course down the arm in the musculospiral groove in which it lies close to the humerus. In this part of its course it may be injured by pressure of the arm as it rests on the back of a chair and from whence it gives rise to that type of involvement referred to as Saturday night paralysis. Fractures of the humeral shaft may cause injury to, or even division of the nerve in this location, and the possibility of pressure or impingement by callus formation produced during the course of healing is recognized.

These considerations would be most incomplete if I did not mention one valuable differential test that may be used to distinguish lesions of the cord that produce signs similar to those seen in lesions of the plexus from those of the plexus alone. Examine the lower extremity as well as the upper; and if it shows signs of involvement, the lesion is one of the medulla spinalis and not one restricted to the brachial plexus.
At a time of national crisis such as the present, rejection of draftees with heart lesions traceable to rheumatic fever in childhood serves to indicate the responsibility which rests with the family doctor in being able to recognize and properly manage rheumatic fever in childhood. In the past two decades many contributions have been made to the epidemiology and natural history of rheumatic disease in childhood; but while the disease is thought to be an infection, no indisputable evidence of its exact nature as such has been produced. The following rather typical case reports may serve to emphasize some of the more common aspects of the disease with which the general practitioner should be familiar.

Case 1. G. M., a four year old colored girl, came to the clinic with the chief complaint of fever during the preceding week with pain and swelling in the right ankle and knee for two days. She gave a history of having had a sore throat about a week before onset of joint symptoms.

First examination revealed a temperature of 102.6 F. and pulse rate of 120. The sedimentation rate was 18 mm. in 60 minutes. The right knee and ankle were tender and swollen. The heart appeared normal except for a soft systolic blow at the apex. The child was put to bed at home and the fever disappeared under the influence of salicylates and osteopathic manipulation. By the fourth day the temperature was 98.6 F. and the child was comfortable and had no complaints. She was kept in bed for six weeks at the end of which time the systolic blow had disappeared and the sedimentation rate had returned to normal.

This child was treated before real damage was done to the heart.

Case 2. C. D., a white boy eleven years old, arrived at the clinic with the complaint of pain in the right thigh and fever for two days. The past history revealed that the boy had had rheumatic fever at the age of six years and had been in bed eight months because of “heart trouble.” He had also been hospitalized before for a period of two months because of joint pains, and had been in bed at home for a month following this.

His temperature on admission was 102.2 F. and his pulse rate 130. There were pain and swelling in both wrists and tenderness in the right knee and hip. The heart outline was boot-shaped with the left border extending to the left anterior axillary line and right border being 2 cm. to the right of the parasternal line. There was a loud blowing diastolic murmur at the aortic area, and a systolic murmur at the apex.

Diagnosis was rheumatic fever with arthritis, aortic insufficiency, and possible mitral insufficiency.

During his hospital stay there were two exacerbations with joint pains and fever. The sedimentation rate fluctuated but was never normal during
the entire stay. Treatment consisted of osteopathic manipulation with proper diet and x-ray therapy. After the patient was afebrile for one week he was discharged from the hospital to be treated at home. When last seen he was free from joint pains, and was gaining weight.

**Case 3.** G. R., a boy four years old, was admitted to the hospital with the chief complaint of recurring joint pains with elevation of temperature. He had been under care of the family physician for the past year and treated intermittently with sulfa drugs. He did not present a history of frequent colds, chronic cough, headaches, asthma or hay fever, or chest pains. His tonsils had been removed one year previously.

Physical examination revealed a slightly asthenic child with a systolic murmur best heard over the apex. Spinal lesions were present in the upper dorsal and lower cervical areas with contracted muscles. The sedimentation rate was 14 mm. in 60 minutes. Hemoglobin was 68 per cent. Wassermann and Kahn were negative. At film examination the mastoid area on the right side evidenced increased radio density in the antral and periantral regions. There was right otitis media. The chest evidenced some changes in both lungs due to a chronic bronchitis bordering on an atypical pneumatic process in appearance. Paranasal pansinusitis. Examination of the heart showed a pulmonic murmur, a symptom suggestive of subclinical rheumatic fever.

The child was hospitalized for four weeks and received daily osteopathic manipulation, diet with plenty of A, D, and C vitamins, iron for the anemia, and injections of whole blood. The sinuses were drained and treated by radiation therapy, and the child's general condition was greatly improved.

**Discussion**

It has long been advocated by Coburn and others that the hemolytic streptococcus plays an important role in the incidence of rheumatic fever yet in my experience this has not been substantiated. In 1931 he said, "The activity of the hemolytic streptococcus is often accompanied by upper respiratory disease." This was substantiated in all three cases as all had upper respiratory affections and cultures of the passage contained streptococci but only one case was of the hemolytic type. Surely the close association between upper respiratory infections and rheumatic fever cannot be ignored. The history of most cases shows the existence of cold or sore throat preceding the onset of frank rheumatic symptoms.

The most characteristic pathologic changes are in the joints, the heart, and the subcutaneous nodules. There are two prominent features which characterize the tissue changes, namely exudation and proliferation. The **exudative process** is exemplified in the effusion into joint cavities, the pericardial sac, and the pleural cavity. The proliferative process is typified in the cellular reaction in the heart muscle and in the subcutaneous nodules. These processes are not independent of each other, but may be seen at the same time.
The major rheumatic phenomena are arthritis, carditis, nodules, and chorea. The clinical course is variable. If untreated the fever and joint pains persist from a few days to several weeks. In general the course tends to be brief if treated. Severe abdominal pain usually generalized or shifting in location accompanies or even precedes the outspoken signs of polyarthritis in a small percentage of cases. When present this symptom may be mistaken for appendicitis and a needless operation often results.

The blood picture in acute rheumatic fever presents a moderate degree of anemia, and the white count is elevated usually between 10,000 and 20,000.

During the clinical course of the disease the heart should be carefully and repeatedly examined. The earliest sign of involvement is usually the development of a soft systolic murmur at the apex with a shift of the apex impulse to the left. After a few weeks there may also occur a mid-diastolic murmur of rumbling character at the apex which is indicative of a definite mitral involvement. These findings at the apex should be sought first of all because the mitral valve, practically without exception, is involved in rheumatic carditis of childhood. A diastolic murmur, best heard over the sternum or in the third interspace at the left sternal margin, soft and blowing in character and beginning immediately following the second sound is another abnormal finding. This indicates the presence of damage to the aortic valve and occurs in a fair share of the cases of rheumatic heart disease in childhood. Once the heart has become involved, and if the symptoms indicate a severe grade of infection, one should be on the alert for evidence of pericarditis, and this too is often accompanied by myocarditis.

The greatest difficulty in the diagnosis of rheumatic fever in childhood is to determine whether or not the obscure "growing pains" involving muscles and joints really represent the presence of rheumatic infection or whether they may be explained on the basis of foot deformities, fatigue, unusual physical exercise, or "grippy" attacks in which generalized aching is often a prominent symptom. A condition frequently confused with rheumatic arthritis is rheumatoid arthritis, especially in the early stages. In the later condition the persistence of joint involvement, long continued fever in the absence of heart involvement, and failure of response to salicylates will serve to differentiate.

Septic arthritis is differentiated by only a few joints being involved; they are more boggy, the aspirated fluid is purulent, and the general condition of the patient is more alarming than in rheumatic fever.

There are several diagnostic tests that are valuable and will serve to confirm diagnosis. The sedimentation rate is a valuable laboratory aid. The Weltman reaction and the formol-gel test are also reliable confirmations.

There is no known method of active immunization against rheumatic fever nor is there a test for susceptibility, so there is no solution for mass control as has been employed in other diseases. We hope, however, that
some day in the near future we shall have some definite means of combating this disease. The best procedures of treatment are prolonged rest in bed, avoidance of respiratory infections, limitation of exposure, and maintenance of good general hygiene and diet.

Much has been advanced on the use of sulfanilamide as a prophylactic measure, but little has resulted from its use. Incidence of toxic drug reaction is exceedingly high, and beneficial results are negligible.

Tarau says, "Many problems are presented in the management of rheumatic disease in childhood." His studies emphasize the following observations:

1. The younger the child at onset, the more severe the initial attack.
2. The more severe the initial attack, the more frequent the recurrence.
3. The more severe the initial attack, the longer the duration of active infection.
4. The younger the child at the age of onset, the more protracted the active rheumatic episodes.
5. The more severe the onset and the younger the child, the greater the cardiac damage at the end of a period of six years.

If the primary aim in treatment is prevention of cardiac damage and prolongation of life expectancy, it would seem obvious that the management of rheumatic disease would be planned upon the basis of age of onset and severity of infection at the time of onset.

Since rheumatic fever is not a reportable disease and it is so prevalent and its ravages go beyond those of other diseases whose causes are unknown, we should concentrate all efforts for the treatment and cure of the disease. The total management of the disease presents a multiplicity of problems invading all aspects of human welfare. It demands an active mobilization of all agencies concerned with health and welfare of childhood population.

Bibliography

The motivation for suicide has been a most fascinating subject to theorize upon. Obviously, the same mechanism does not operate in all cases. In any event, those who are impelled to take their own lives are not always successful. This lack of success may be the result of a faulty method or perhaps a change of heart. It has been pointed out by experts in this field of investigation that in hanging the victim has little, if any, opportunity to change his mind. Once the noose has been tightened about the neck shock occurs so rapidly with anoxia of the brain that the victim is helpless.

The case here to be presented is of one who had attempted suicide twice before success was accomplished. Once the wrists were slashed. The numerous "hesitation cuts" and the superficial nature of the cuts attested to suicidal intent. On another occasion the victim is said to have jumped from a height (elevation undetermined) with fracture of the external table of the skull. This second attempt failed with recovery from trauma. The third and last attempt was by hanging during which there was no possibility of a change of heart.

Autopsy No. 44-797
Pronounced dead: 3/12/44—4:45 p.m.
Autopsy: 3/14/44—2:00 p.m.
At the City Morgue

Clinical Data
"Deceased was found hanging in a shack. . . . He apparently was dead for some time."

External Examination
The body was that of a white male said to be 42 years old. His length was 67 ½ inches, and his weight was estimated at 145 pounds. Decomposition of the body was evident leading one to believe that the body had been dead for several days before having been found.

A thin crop of gray hair was noted around the crown of the cranium. A cicatrix extended from above the right eye across the vortex to the occiput on the same side. The pupils were equal in size but the eyes had

* Case reported through the courtesy of Dr. Benjamin Gouley, Chief Coroner’s Physician, City of Philadelphia.
undergone some softening. There was a light growth of whiskers on the face. The tongue protruded through the mouth. There were no teeth in the upper jaw and snags in the lower jaw. A deep furrow was demonstrated in the upper neck under the angle of the jaw and extending toward the occiput. This deep impression had all the characters and markings of strangulation by hanging.

There was great lividity of the hands, the forearms, the legs, and the feet with the blood vessels well marked and with some petechial hemorrhage. Numerous scars were demonstrated upon the flexor surface of each wrist. On the right wrist there were five sutured scars. On the left wrist there were six sutured scars, and on each side there were numerous hesitation scars as evidence of previous attempts at suicide. The right hand was chewed on the extensor surface, evidently by rats.

The abdomen and pubic region had recently been clipped of hair, one would judge in an attempt to control pediculosis pubis. These lice were demonstrated in considerable numbers about the pubes and body generally. The penis and scrotum were swollen by edema and lividity. The lower abdomen was somewhat bulging and discolored green.

**Internal Examination**

The subcutaneous fat over the abdomen was 2 cm. in thickness.

About 5 cc. of bloody fluid was found in the pericardial sac. The heart measured 11 x 9 x 5.5 cm. The greatest diameter of the thorax at the upper level of the diaphragm was 22 cm. with a cardiothoracic ratio of 11/22. There was some thickening of the mitral curtain suggesting the possibility of previous attacks of rheumatic carditis. The right heart was greatly dilated. There was very little atheromatous degeneration in the aorta, and none was demonstrated in the coronary system.

Adhesions were found scattered into the pleural cavities, suggesting the possibility of previous attacks of inflammatory disease. A considerable quantity of mucoid exudate was found in the right main stem bronchus, and tenacious mucus was found in the left bronchus. Reinfec tion lesions of pulmonary tuberculosis were demonstrated in the apices. Here and there a bullous emphysema was demonstrated in the peripheral portions of the lung, chiefly in the apices.

The esophagus presented no noteworthy lesions.

The stomach was empty and presented no noteworthy lesions.

The intestines contained a moderate amount of fluid and food remnants but no organic lesions.

The appendix and cecum were quite high, just directly under the liver. The colon presented no noteworthy lesions.

The liver was 10 cm. tall. The gallbladder emptied readily upon pressure but showed some cholesterolosis in its walls. The bile was pale and there were no calculi.
The pancreas presented no noteworthy lesions.

The spleen measured 12 x 6 x 4 cm. and was of increased density with some hyperplasia of the stromal elements.

Phimosis was demonstrated with a great accumulation of debris about the glans penis. The urinary bladder contained less than 25 cc. of urine. The ureters were not dilated. The prostate was estimated as being of average size. The kidneys measured respectively, left and right, 12 x 8.5 x 3.5 cm. and 11 x 6 x 3 cm. The capsules stripped with some difficulty, but the cortical substance was neither irregular in thickness nor thin.

The suprarenal glands showed some absorption of the medullary substance.

The cicatrix in the scalp was investigated and was found associated with an old healed fracture of the outer table of the skull extending from a point just over the right eye in the frontal bone through the right parietal bone to the right occiput. There was no evidence of fracture of the internal table. Dissection of the cranial areas showed no fractures of the vertebrae and no fractures of the larynx.

Gross Anatomical Diagnosis

Strangulation by hanging.

Cause of Death

Strangulation by hanging.
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