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Irradiation of the nasopharynx as a prophylactic measure against chronic upper respiratory infections and their aftermath : a review of American literature

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IRRADIATION OF THE NASOPHARYNX AS A PROPHYLACTIC MEASURE AGAINST CHRONIC UPPER RESPIRATORY INFECTIONS AND THEIR AFTERMATH: A REVIEW OF RECENT AMERICAN LITERATURE

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INTRODUCTION

For many years it has been generally understood that one of the principle factors leading to recurrent infections of the upper air passages and ears is infected lymphoid tissue in the nasopharynx. Bordley (1) stated that the two chief causes for the failure of surgical removal of infected lymphoid tissue in the nasopharynx are the inaccessibility of this tissue and a tendency of lymphoid tissue to hypertrophy following upper respiratory infections.

Irradiation of the nasopharynx by various methods has been carried on for more than fifty years. This treatment has been used for a variety of benign conditions, including chronic suppurative inflammation of the middle ear, eustachian tube deafness, recurrent or persistent colds, chronic cough associated with excess postnasal drip, asthmatic conditions in which there is an increase of the severity of the symptoms with recurrent sore throats and colds, arthritic conditions in which there is an accentuation of symptoms with colds, chronic upper respiratory infection, impaired hearing, recurrent otitis media, and other conditions in which hypertrophy and/or infections of the naso-

pharyngeal lymphoid tissue may be indicted as causative factors.

Among the methods used have been roentgen ray and radium or radon applicators. Each of these methods of treatment has its indications and contraindications, advantages and disadvantages, and there is a great deal of disagreement in the literature as to the exact nature of these.

ANATOMICAL CONSIDERATIONS

Garland, Hill, Mottram, and Sisson (2) outlined some of the anatomy involved in the nasopharyngeal region. Adult eustachian tubes are about 3.6 cm. in length with orifices averaging 4 cm. apart. The outer third of the eustachian tube is bony, joining the inner two-thirds at an isthmus, the narrowest part of the tube. The tube widens as it approaches the pharyngeal orifice. Normally, throughout the mesial one-half the walls of the tube are apposed. The ostium is vertical and slit like, except when forced open by muscular action or positive pressure. The torus tubarius, a bulge of cartilage covered by mucosa, surrounds the nasopharyngeal orifice above and behind. The fossa of Rosenmuller is above and behind the torus and is

lined with lymph follicles and lymphoid tissue. On the roof and upper posterior wall of the nasopharynx lies the adenoid. The adenoid may be extensive and encroach upon the fossa of Rosenmuller, and may even extend over the torus tubarius. There are scattered bands of superficial lymphoid tissue lying on the posterior and lateral walls of the pharynx and nasopharynx. These bands and scattered nodules of lymphoid tissue are more developed superiorly in the nasopharynx. The thickness of this tissue averages 2 mm., and lymphoid tissue has been shown to be absent about normal eustachian orifices. Lymphoid tissue, in the presence of acute or chronic infection, may be present anywhere along the eustachian tube and even in the middle ear, but this tissue is most prominent at the pharyngeal end of the tube. The pharyngeal ostium of the eustachian tube is said to act as a flutter valve, allowing the escape of air under pressure from the middle ear, but preventing passage of air inward to the middle ear.

Day (3), after having examined the nasopharynx of hundreds of children with a nasopharyngoscope, stated that he considered it a rarity to find lymphoid tissue obstructing the lumen of the eustachian tube, but that,

as a rule, there is some lymphoid tissue in the vicinity of the tube orifice, and that in many instances lymphoid tissue impinges on or overlaps the tube orifice.

Bordley (1) has said that lymphoid tissue is an integral part of the posterior and lateral walls of the pharynx and nasopharynx and that after surgical removal of adenoids in children, upper respiratory tract infections may cause regrowth of this tissue. He observed that lymphoid tissue does not completely occlude the orifice of the eustachian tube as a foreign body might, but when infected, impairs proper aeration of the middle ear by edema of the tubal mucosa and excessive activity of the many mucus glands lining the tubes. Retrograde spread of infection into the middle ear may occur by this mechanism.

PATHOLOGICAL CONSIDERATIONS

Lymphoid tissue of Waldeyer's ring, more plentiful in childhood, begins to atrophy at the time of puberty unless infected. With infection this tissue may persist, with or without scar formation. Repeated infections may give rise to adhesions, binding the adenoids to the torus. This lymphatic tissue is in close assoc-

iation to the nose, sinuses, and eustachian tubes. The close association is a factor in frequent infection of these structures.

Normally, air exchange between the nasopharynx and the middle ear is very slow. The normal tube does not open with each act of swallowing, and may remain closed for long periods of time each day. Lymphoid hyperplasia or edema around the orifices or in the eustachian tubes, if prolonged, lead to changes in the middle ear. Chronic or repeated infections of this tissue may act as a focus of infection and lead to sinusitis or otitis. The torus tubarius shows marked inflammatory change after infection and may totally obliterate the eustachian orifice. There are no clinical means to determine the lymphoid infiltration of the tubal wall, but one may infer its presence when hypertrophy of lymphoid tissue of the pharyngeal walls, torus, or fossae exists.

DESCRIPTION AND EVALUATION OF NASOPHARYNGEAL IRRADIATION

IN GENERAL

Schenck (4), in his discussion of the physiology of lymphoid tissue, including that of the nasopharynx, stated that lymph tissue is the probable site of anti-

body formation, and that lymph nodes nearest the site of an intradermal injection of bacteria or viruses form antibodies before they appear in appreciable concentration in the blood. He pointed out that lymphocytes function thus in the attenuation of bacterial and viral agents at the same time the nodes, which they form, filter infective and particulate material. He stated that acute involution of lymphoid tissue, such as results from irradiation, releases infectious and deleterious agents from imprisonment in the lymph tissue. Exclusive of other considerations, the above observations would mitigate against irradiation of normal tissue in the nasopharynx, or irradiation of acutely infected lymphoid tissue in the nasopharynx.

Bordley (1) emphasized that large central masses of adenoid tissue should be surgically removed before irradiation, since irradiation is not as effective if carried out in the presence of these masses.

Irwin (5) commented on the impossibility of removing all excess nasopharyngeal lymphoid tissue by surgery, particularly that surrounding the orifice of the eustachian tube and that in the fossa of Rosenmuller. He stated that for almost thirty years the excess lymphoid tissue, remaining after surgery, has

been successfully removed by irradiation.

Michels and Lomhoff (6), among many others, also agreed that surgical removal of a large adenoid mass, followed by irradiation, is always more satisfactory than irradiation alone.

Garland et al (2) contended that the treatment of choice in hyperp asia of lymphoid tissue of the naso-pharynx is irradiation therapy, since this hyperplastic tissue is not amenable to surgical removal. They pointed out that this therapy could be applied either by external or intra-oral use of roentgen rays or by nasopharyngeal application of radium.

IRRADIATION OF THE NASOPHARYNX BY NASOPHARYNGEAL APPLICATOR

Smith and Scharfe (7) described various methods of screening or filtering radium emanations to remove the longer length beta rays. Among metals used for this purpose have been platinum, brass, and monel metal. Platinum screens out all beta rays, brass allows 7-8% of the beta rays to pass, while monel metal passes about 75% of the beta rays.

The most common nasopharyngeal applicator in use at present contains 50 mgm. of radium sulfate enclosed

in a tubular monel metal chamber, 15 mm. in length and 2.3 mm. in outside diameter with wall thickness of 0.3 mm.. This container is mounted on a handle 18 cm. in length. It is used by passing it along the floor of the nose to the eustachian tube orifice. It has been found that approximately 75% of the beta rays are absorbed in the first 3 mm. of tissue. The recent trend has been to increase the dosage and shorten the time between treatments with this applicator. A typical course of treatment consists of an 8½ minute application of irradiat on in the region of each eustachian orifice, given 3 times at 2 to 3 week intervals.

Hardy and Bordley (8) reviewed the literature and concluded that infected lymphoid tissue in and around the pharyngeal orifices of the eustachian tubes may lead to permanent damage to structures of the middle ear. They stated that this excess lymphoid tissue could be painlessly removed by use of either the radium or radon gas nasopharyngeal applicator. They declared that early recognition of symptoms suggesting a predilection for damage to the middle ear structures, indicated by hearing impairment associated with upper respiratory conditions, was essential in the prevention of severe hearing loss. In these cases, especially in

children, they suggested that lymphoid hyperplasia of the nasopharynx be treated with the nasopharyngeal applicator, containing either radium salts or radon gas, as a prophylactic measure to prevent further hearing loss.

Bordley (9), after reviewing many studies, came to the conclusion that irradiation of the nasopharynx by radium sulfate or radon applicator was effective in reducing lymphoid masses near the eustachian orifices. He advised against this technic being used for the removal of large central adenoid masses.

In another paper Hardy and Bordley (10) stated that they had found that children irradiated with the radium nasopharyngeal applicator showed reduction not only in adenoid masses, but more markedly a decrease of lymphoid overgrowth and edema around the eustachian orifices. These effects were manifest by the first 18 months after irradiation, and seemed to persist for the balance of the five year study.

Braestrup (11) determined, among other things, the tissue dosage in roentgens at various depths in the tissue produced per unit time by the standard monel metal radium applicator. He found that, for a small volume of tissue close to the applicator, the

doses clearly exceeded those commonly used in any other type of radiotherapy for nonmalignant conditions. He thought that the low incidence of radiation injury to the nasopharynx, following this form of therapy, might be explained by the small amount of tissue receiving this high dosage. On the basis of his investigation, he cautioned the therapist concerning the danger of subjecting himself to irradiation injury while using the applicator. The therapist's fingers were found to receive the permissable weekly exposure while treating three patients.

Day (3), in a paper on the abuse of nasopharyngeal irradiation, by use of the monel metal radium applicator, criticized its indiscriminate use. He attributed this indiscriminate use to the false premise that it could do no harm, to national advertising, to the public appeal of the aura of mysticism of radium as a cure for deafness, and to it's being a supposed non-surgical cure. He granted that most of these applicators had been purchased with the highest of motives, but at the same time classified this therapy as "big business". Over two million dollars have been invested in radium applicators. He condemned their usage for such conditions as head colds, tinnitus, chronic cough,

allergy, and as routine post-operative treatment following tonsillectomy and adenoidectomy. He stated that in many instances the nasopharynx was not even examined before irradiation.

Bilchick and Kolar (12) pointed out that the calculated dosage is not often delivered by the nasopharyngeal applicator. This dosage is calculated on the basis that the side of the applicator is exactly on the eustachian orifice. He found that exact placement of the applicator, especially in small children, was prevented by variable dimensions of the nasopharynx and inferior turbinates, narrow nares, and septal deviations. He stated that the delivered dose was almost invariably less than the calculated dose.

Garland et al (2) declared that, because of the relatively intense radiation near the surface of the nasopharyngeal applicator and the rapid decrease of this radiation with distance, it was effective in treating localized, but not generalized, lymphoid hyperplasia of the nasopharynx.

Irwin (5), by means of x-ray films, showing dummy nasopharyngeal applicators in place in the nasopharynx, demonstrated that the average placement of these applicators in the nasopharynx during treatment is very

inaccurate. Consequently, the calculated dosage is very unlikely to be delivered upon the target tissue.

IRRADIATION OF THE NASOPHARYNX BY X-RAY

There is considerable variation in the modes of treatment of lymphoid hyperplasia of the nasopharynx by roentgen ray. Reeves (13) used 100 kv., constant potential, and 3 mm. aluminum filter x-ray for 4 to 6 weekly treatments to the nasopharynx, but, because many patients required a repeat series, he changed the routine to 200 kv. with a ½ mm. Cu and 1.0 mm. Al filter. The dosage consisted of 550 r to each side of the nasopharynx in four weekly divided doses. The rays were directed through a 4 x 6 cm. cone up beneath the eustachian tube toward the mid-pharynx. He asserted that little intervening tissue was irradiated, the rays being directed up and behind the parotid gland. He also cited a method of directing rays through the maxillary antra to the nasopharynx as being very good, especially with a low grade sinus infection. Kander and Sicher (14) used 200 kv., 10 ma., Thoraeus filter x-ray through a 8 x 6 cm., or 6 x 4 cm. port to both sides of the nasopharynx. The centering point on the skin was, on the average, 2 cm. in front of the external

auditory meatus. They gave a total of 1000 r in five daily divided doses. Irwin (5) described a method of intra-oral administration of x-ray to the nasopharynx, and stated that with this approach no x-ray reached the parotid gland.

Various advantages of x-ray irradiation of the nasopharynx have been pointed out by many authors, while others deny the incidence of complications due to nasopharyngeal x-ray therapy, claimed by proponents of the radium applicator. Kander and Sicher (14) stated that in their experience, because of the atraumatic nature of the treatment, they had not found it difficult to treat even nervous children by x-ray. They denied skin erythema, dryness of the throat, or other complications of irradiation therapy. Reeves (13) also found roentgen therapy to be easily given to children. He further stated that with roentgen therapy the entire pharynx is treated, and denied demonstrable radiation damage in his series of 1200 cases.

Irwin (5) agreed that damage to the growing mandible may result from x-radiation of the mandible for tumor, but denied any evidence of this damage due to the small dosage used for the destruction of excess lymphoid tissue in the nasopharynx. Garland et al (2)

considered roentgen therapy of the nasopharynx to be the simplest and safest method available for irradication of excess lymphoid tissue. He enumerated advantages of this method such as no anesthesia required; painless treatment; irradiation of the lymphoid bearing area of the nasopharynx, including the entire tubes, adenoids, fossa of Rosenmuller, and scattered lymphoid deposits on the nasopharyngeal walls.

TREATMENT OF VARIOUS BENIGN CONDITIONS BY IRRADIATION OF THE NASOPHARYNX

TREATMENT AND PREVENTION OF DEAFNESS BY IRRADIATION OF THE NASOPHARYNX

Is the Treatment Potentially Harmful?

Irradiation of the nasopharynx has been used for over twenty-five years in the treatment and prevention of hearing losses due to lymphoid hyperplasia of the eustachian tubal orifices. There has been a great deal of controversy concerning the most effective type of irradiation and the most effective mode of application of this irradiation. The chief difference of opinion seems to center around the relative merit of external or intraoral use of roentgen rays, or local nasopharyngeal application of radium. Radon

applicators have also been used in the past, but have been replaced by radium applicators.

The great bulk of reports regarding the use of the radium applicator in the nasopharynx state that the treatment is harmless and that no untoward effects have been observed.

Mueller and Flake (15) said, concerning twenty-six children who had a series of three 8 to 10 minute applications of radium in the standard 50 mg. monel metal applicator to each side of the nasopharynx, that the untoward effects were minimal and consisted of some local discomfort at the time and some nasal stuffiness for about twenty-four hours.

Smith and Scharfe (7) said that no reports of untoward results following irradiation of the nasopharynx had yet been published, but cautioned that insufficient time had elapsed for late damage to become apparent.

After a follow-up study of 263 patients treated by radium irradiation of the nasopharynx more than five years previous to the follow-up, Loch and Fischer (16) concluded that there were no late detrimental effects of irradiation or any visible tissue pattern that could be explained as due to the application of

radium.

Lederer (17), who has used irradiation on the nasopharynx for over 27 years, stated that he had yet to observe any neoplastic change occurring in any of the patients treated. He further declared that personal communications with radiologists who had used both x and r irradiation for over three decades failed to reveal a single case of neoplastic change in the nasopharynx.

Five years after the nasopharyngeal radium irradiation of 192 children, Hardy and Bordley (18) found no evidence of trauma relatable to the treatment.

Day (3) stated that he felt sure that routine examinations of the nasopharynx in cases that have received irradiation in the past will reveal more and more evidence of the occasional destructive effect of this form of therapy.

Bilchick and Kolar (12) told of one case in which a biopsy of the nasopharynx was taken four weeks after the last of multiple irradiations of the nasopharynx by both x-ray and radium. This biopsy material showed such numerous mitotic figures in the epithelium that the pathologist considered the possibility that it might be the onset of an intramucosal carcinoma.

They emphasized the importance of examination of the throat and nasopharynx for irritation or acute infection, and close questioning of the patient concerning previous irradiation before this type of treatment is used.

Garland et al (2) stated that radium irradiation of the nasopharynx is not as harmless as generally considered, and that there have been cases of radium ulcers on the posterior nasopharynx following approved dosages of irradiation.

Effectiveness of Treatment of Deafness by Radium Irradiation of the Nasopharynx:

In 1948 a five year joint project, in which Johns Hopkins Hospital participated, was started to determine, among other things, the changes taking place in hearing acuity following nasopharyngeal irradiation. A group of 582 children in the third grade, averaging 8.5 years of age, were selected for the study on the basis of a hearing impairment of fifteen decibels or more in two tones, or twenty decibels or more in one tone. The group was then divided by a random alternation into two sub-groups. Both sub-groups were treated with nasopharyngeal applicators, but one sub-group was

treated with placebo applicators, while the other sub-group was treated with radium applicators. The overall hearing improvement of the two sub-groups was surveyed at the end of five years, at which time the children had reached early puberty. There was a uniform small gain of the treated sub-group over the control sub-group for all octaves, but it was too small to be statistically significant. Both sub-groups showed improvement of hearing in all octaves, ranging from 7 to 13.4 decibels. The authors of this study, Hardy and Bordley (18), attributed this improved hearing in both sub-groups to factors such as puberty, practice in listening to audiometric testing, and improved nasopharyngeal hygiene. These two sub-groups were further broken down into sub-groups: (1) hearing impairment in low range, (2) hearing impairment in high range, (3) hearing impairment in both ranges. Sub-groups 1 and 2 were little benefited by irradiation, but sub-group 3, in which there was impairment in both ranges, showed gains in the various octaves, due to the irradiation, varying from 5.7 to 10.8 decibels. Sub-group 3, in which there was such remarkable improvement in hearing due to nasopharyngeal irradiation, had the classical conductive type of hearing loss.

Guild (19) reported on another study of hearing in children at Johns Hopkins School of Medicine, which was completed in 1947. In this study, 1365 children were selected on the basis of enrollment in certain classes of certain schools. The average age of the children at the time of their first examinations was 9½ years, and at the time of their last examination slightly over 16 years. The children were divided into two groups: children with good hearing, not treated; children with impaired hearing, treated with radium applicator to the nasopharynx. The group with impaired hearing was further subdivided into (1) "gradual" high tone losses, (2) "abrupt" high tone losses, (3) moderate impairment of hearing of all tones, (4) severe impairment of hearing.

From the children with normal hearing, it was learned that hearing acuity in the low ranges improved slightly during the period of observation, in the middle ranges remined practically constant, and in the high ranges increased slightly. This same group, through observation of the nasopharyngeal lymphoid tissue at the beginning and the end of the study, yielded the information that there was no correlation between the quantity of lymphoid tissue near and about

the orifice of the eustachian tubes and hearing loss during the period of observation.

From the treated children with impaired hearing it was learned that with irradiation there was a slight gain in hearing acuity for the frequencies 8192 to 13004 cycles in the group with "gradual" high tone losses, that "abrupt" high tone type losses progressed in spite of irradiation of the nasopharynx, and that children with moderate impairment of hearing for all tones, irradiated and re-examined at the end of the study, showed from 12 to 22 decibel gain in hearing in the various octaves, the greatest gain occurring in the range 4096 to 8192 cycles.

Bordley (1) recommended irradiation of the nasopharynx, by either the radon applicator or the radium applicator, as an effective method of improving conductive type hearing losses resulting from chronic or intermittent auditory tube obstruction. He cautioned that individuals with irreversible lesions of the auditory tubes or of the middle ears, even when associated with lymphoid hyperplasia about the auditory tube orifices, would not be helped. He accordingly recommended the taking of a careful history, a complete examination of the nasopharynx and ears, and tests of

hearing in order to rule out the irreversible lesions mentioned above. He stated that the results of irradiation of the nasopharynx for conductive type hearing loss were better in children than in adults. He found conductive type hearing losses in children, which were exacerbated by upper respiratory infections, to be particularly amenable to treatment by irradiation.

Smith and Scharfe (7) reported on a series of fifty cases, which had been treated by radium applicator to the nasopharynx. Twenty-two of these cases were eustachian tube obstruction in children between five and thirteen, with chief complaint of persistent or recurrent deafness, aggravated in many cases by upper respiratory infections. The duration of symptoms in this group varied from four months to ten years, the average being 2.8 years. Fifty-six percent of the ears treated for eustachian tube obstruction showed at least a ten db. improvement for the speech frequencies. Seven cases of mixed deafness were treated, it being felt that some degree of tubal obstruction was present. Only one of these cases showed good audiometric response. Smith and Scharfe advocated a careful history, audiometric testing, and visualization of the tympanic membrane and nasopharynx before submitting

a patient to irradiation for treatment of deafness. They concluded that deafness due to eustachian tube obstruction frequently clears up under conservative treatment, that irradiation of nasopharyngeal lymphoid tissue does not replace a properly performed adenoidectomy, that other causes of eustachian tube obstruction, such as sinusitis, allergy, etc., should be considered, and that tubal patency should be determined before considering irradiating the nasopharynx.

Loch and Fischer (16) evaluated the results of radium applicator irradiation of the nasopharynx of 243 patients who had hearing loss. The treatment of these patients had occurred more than five years previous to this evaluation. They concluded that the patients who showed improvement of hearing acuity, almost without exception, had a conductive type of hearing loss; that those with an acquired or congenital perception deafness, or otosclerosis, either remained stationary or became worse in the course of the years.

In a study of the results of irradiation of the nasopharynx with the radium applicator for deafness, Bilchick and Kolar (12) divided their patients into two groups. One group, children up to 15 years,

contained 68 patients, and the other group, patients over 15 years, contained 102 patients. In the first group, those under 15 years of age, 37 to 48 cases of conductive deafness resulted in substantial improvement, and 1 of 22 cases of nerve deafness showed improvement. In the second group, those over 15 years of age, 36 of 72 cases of conductive deafness showed improvement, and 2 of 30 cases of nerve deafness were improved.

Garland et al (2), reporting on a study of the effect of irradiation of the nasopharynx with the radium applicator at Johns Hopkins Hospital, stated that, of 282 patients with impaired hearing attributable to obstruction of eustachian tubes, 85% had "great and lasting" improvement.

Day (3) stated that, in spite of beneficial results of irradiation of the nasopharynx in the treatment of conductive deafness reported by others, he was greatly disappointed over results obtained in his experience. Over 100 cases, revealing lymphoid tissue overlapping or impinging on the mouth of the eustachian tube, were treated with from 3 to 6 irradiations with the nasopharyngeal radium applicator. Less than 5% of these cases showed any permanent effect on the patentcy

of the eustachian tubes or the ventilation of the middle ears after irradiation. He stated a few cases with obviously inflamed and infective lymphoid tissue were definitely helped.

Effectiveness of Treatment of Deafness by X-ray Irradiation of the Nasopharynx:

Reeves (13) reported on a group of 1268 patients treated by x-ray to the nasopharynx. Among these were 38 cases of impaired hearing thought to be attributable to a focus of infection in the nasopharynx. He reported 75% of these were relieved completely and 25% improved.

Michels and Lomhoff (6) conducted a study on the results obtained in the treatment of deafness in 97 patients, ranging from 4 to 19 years of age. The treatment consisted of five weekly doses of 108 r in air for a total dose of 540 r to left and right eustachian tube areas through portals measuring 5 x 5 cm.. Surgical removal of adenoid tissue was done prior to irradiation. Of the 97 cases of deafness, good to excellent improvement in hearing was obtained in 47, partial improvement was observed in 33, and no improvement occurred in 17. Seventeen of the 97 showed

demonstrable clinical allergy. Hearing improvement of these 17 patients was found to be less than in the remaining members of the group. The authors have noted that irradiation does not control allergic episodes, which depress auditory function either temporarily or permanently. In analyzing their results, according to type of audiometric curve, 56 of 62 cases with a "flat" type of loss showed improvement. Two of 12 cases with a high level "sharp" depression showed improvement. Five of 30 cases of upper level loss (4000-8000 cycles) showed improvement in hearing in the upper levels.

Garland et al (2) used 4 to 6 weekly doses of 100 kv. and 3 mm. aluminum filtered x-ray therapy to each side of the nasopharynx in treating 720 patients for lymphoid hyperplasia in the nasopharynx. Patients were referred by otolaryngologists or general practitioners. Evaluat on of results was made by the patients or the referring physicians. One referring otolaryngologist noted that 55% of his adult patients, with deafness secondary to hyperplastic lymphoid tissue around the eustachian orifices, were cured with a single course of irradiation.

TREATMENT OF ASTHMATIC CHILDREN BY IRRADIATION OF THE NASOPHARYNX

Mueller and Flake (15) conducted a study of the results obtained by nasopharyngeal irradiation of 41 asthmatic children. These children had been observed for periods of six months to four years, with 85% of the children followed for two years or more. The children reported in this study fulfilled the requirements of a history of severe asthma for over two years duration associated with respiratory infections, failure to obtain satisfactory results with other methods of treatment for infectious asthma, stabilization by allergic treatment of any accompanying asthma due to other allergens, and the finding of hypertrophied and/or infected lymphoid tissue in the nasopharynx. The patients were graded on the basis of the intensity of their asthmatic attacks and the frequency of their respiratory infections on the scale 0 through 4, 4 corresponding to constant asthma day and night, with frequent respiratory infections always accompanied by asthmatic attacks of greater intensity. Twenty-six of the children were treated with nasopharyngeal radium applicator, and fifteen were treated by roentgen irradiation. There was no notable difference in results

obtained by the two modes of treatment, and consequently all 41 children were considered in one group for analysis. All but one child had undergone tonsillectomy and adenoidectomy at least one year prior to this treatment. Slightly more than half of those having tonsillectomy and adenoidectomy reported temporary improvement after the operation. Sensitivity to other allergens was present in 92% of the children. Hyposensitization treatment in 76% of the patients brought about demonstrable increased benefit from the irradiation treatment. Eleven of the 41 patients obtained complete relief by irradiation for periods from two to four years. Seventeen patients obtained excellent results for periods from 18 months to four years. Five patients obtained only fair results. Eight patients obtained unsatisfactory results. It was concluded that irradiation of the nasopharynx, in children who have asthma associated with respiratory infections, is of definite value. The authors stated that the mechanism affording relief in these patients is not thoroughly understood, but advanced as possible factors elimination of foci of chronic or recurring infection, lessening of secretions, reduction of mechanical obstruction, and changes in the bacterial flora. Another

possible mechanism, suggested by some workers, is the possibility that irradiation changes tissue locally in a manner that might increase the threshold of absorption for allergens. This last mechanism is denied by many, who have pointed out that the nasopharyngeal mucosa, having a comparatively small area, provides little surface for absorption of allergens in comparison to the total surface area of the respiratory tract. It was pointed out that the results of this series in no way contraindicated tonsillectomy and adenoidectomy in asthmatic children.

Loch and Fischer (16), after having irradiated the nasopharynx with the radium applicator for other reasons, obtained as a by-product of this irradiation significant improvement in patients, especially children, who had frequent head colds, excessive coughing, and asthma.

TREATMENT OF RECURRENT OTITIS MEDIA AND CHRONIC SUPPURATIVE OTITIS MEDIA BY IRRADIATION OF THE NASOPHARYNX

Effectiveness of Treatment of Chronic Suppurative Otitis Media and Recurrent Otitis Media by Radium Irradiation:

Smith and Scharfe (7), using the 50 mgm. monel metal applicator for 8½ minutes on each side of the

nasopharynx, in a series of three treatments in a four week period, treated 7 cases of chronic suppurative otitis media in adults. With one exception, audiometric improvement in these cases was insignificant. Of the 12 chronic suppurating ears treated, 5, when last seen, were dry and 2 had intact drums. The follow-up period varied from 3 months to 21 months, the average being 10½ months.

In a five year follow-up study of 263 patients, who had had radium applicator irradiation of the nasopharynx for various conditions, Loch and Fischer (16) found that 54 out of 60 patients with recurrent otitis media showed an estimated 50-100% improvement of symptoms, while the remaining 6 patients showed an estimated 0-25% improvement. It was their opinion that the favorable results of radium treatment on recurrent otitis media were unquestionable. Patients in the group of 60 just described had, for the most part, many different types of treatment, including repeated surgical removal of the adenoids, without permanent results. The authors pointed out that antibiotics will cure acute otitis media, but if the primary cause, hypertrophic lymphoid tissue in or around the pharyngeal orifice of the tubes, is ignored, repeated infections

may occur and lead to irreversible middle ear changes and permanent impairment of hearing.

Effectiveness of Treatment of Recurrent and Chronic Otitis Media by X-ray Irradiation:

Kander and Sicher (14) applied deep x-ray therapy to the nasopharynx through 6 x 4 cm. bilateral ports centered 2 cm. in front of the external auditory meatus. On five successive days 200 r through each port was applied to the nasopharynx. Twenty-one cases of recurrent and chronic otitis media in children were treated in this manner. All of these children had long before undergone tonsillectomy and adenoidectomy. Sixteen of the 21 children were reported as improved, while 5 were reported as showing no change.

TREATMENT OF RECURRENT OR PERSISTENT COLDS, CHRONIC COUGH, AND POSTNASAL DRIP BY IRRADIATION OF THE NASOPHARYNX

Effectiveness of Treatment of Recurrent Colds and Chronic Cough by Radium Irradiation:

Loch and Fischer (16) noted an incidental finding in patients, especially children, who received radium applicator irradiation of the nasopharynx. This finding was a marked improvement in patients who had

frequent head colds or excessive coughing. These patients, returning several weeks or months after their irradiation treatment for other conditions, volunteered the information that their colds were less frequent and less severe and that they coughed less.

Effectiveness of Treatment of Recurrent Colds, Chronic Cough and Postnasal Drip by X-ray Irradiation:

Eight patients with colds and nasal obstruction were treated with x-radiation of the nasopharynx by Kander and Sicher (14). The authors reported marked improvement in 4 cases, slight improvement in 2 cases, and no improvement in 2 cases. These patients were treated for deafness or recurrent otitis media, but had colds or nasal obstruction in addition.

Reeves (13) reviewed over 1200 cases treated with roentgen ray therapy to the nasopharynx at Durham, North Carolina. When these 1200 cases were divided according to pre-irradiation symptoms, the largest group was found to be made up of adults and children who had recurrent or persistent colds with or without cough. Over 70% of the 721 cases in this group showed marked improvement after irradiation. In another group cough was the presenting symptom with or without sore

throat or cervical adenitis. These patients frequently gave a history of postnasal drip with cough greatest after arising in the morning. This cough was characteristically decreased after the bronchi were cleared of mucoid secretion. Patients in this group usually showed a diffuse lymphoid hyperplasia. It was stated that the cough was frequently relieved after 3 or 4 roentgen treatments over the nasopharynx. In this group, containing 324 cases, 72% were considered improved and 28% to be completely relieved.

TREATMENT OF OTHER CONDITIONS BY IRRADIATION OF THE NASOPHARYNX

Reeves (13) stated that his group had x-radiated the nasopharynx of 129 patients with systemic infection, such as arthritis. These infections were characterized by accentuation of symptoms with frequent colds. He stated, "Some of these cases were treated routinely, hoping to find a focus of infection". There was no statement of results obtained.

Michels and Lomhoff (6) found that treatment by roentgen ray for hearing loss in the allergic child was quite unsuccessful, and stated that irradiation did not control allergic episodes which depress audi-

tory function either temporarily or permanently.

Garland et al (2), in a review of the literature, reported different observers' findings as follows: 90% improvement in aero-otitis media after 3 to 8 10 minute radium treatments; improvement in 90% of 112 patients treated with radium therapy to the nasopharynx for complaints thought to be attributable to a focus of infection in the nasopharynx; 90% of 87 patients with partial nasal obstruction due to adenoid tissue were completely relieved and the other 10% improved with radium therapy; 3 of 97 patients with tinnitus treated by radium therapy to the nasopharynx had relief; 8 of 9 patients with fullness in the ears treated with radium therapy to the nasopharynx were relieved; roentgen therapy provided "90% good results" in children with tonsillitis, sore throat, mouth breathing, nasal obstruction, otitic complaints and, in some cases, asthma.

SUMMARY

It has long been common knowledge that infected nasopharyngeal lymphoid tissue is an important cause of recurrent infections of the upper air passages and ears. In many cases surgery alone has not been effect-

ive in the removal of this infected lymphoid tissue. For more than fifty years irradiation of the nasopharynx by various methods has been employed successfully in those cases resistant to surgical therapy.

Infected or hypertrophied lymphoid tissue of the nasopharynx has been indicted as a causative factor in a wide variety of benign conditions. A partial list of these conditions includes chronic suppurative inflammation of the middle ear, eustachian tube deafness, recurrent or persistent colds, chronic cough associated with excess postnasal drip, asthmatic conditions in which there is an increase of the severity of the symptoms with recurrent sore throats and colds, arthritic conditions in which there is an accentuation of symptoms with colds, chronic upper respiratory infection, impaired hearing, and recurrent otitis media.

At the present time irradiation of the nasopharynx is most commonly carried out by the use of x-ray or various forms of radium applicators. The great bulk of controversy concerning nasopharyngeal irradiation centers about the relative effectiveness of these two forms of treatment.

Physical and pathological considerations pertinent

to this paper are salient structural relations in the nasopharynx, the distribution of lymphoid tissue in the nasopharynx, the effect of infection on lymphoid tissue, and eustachian tube mechanics and their disruption by infected or hypertrophied lymphoid tissue.

The torus tubarius, a bulge of cartilage covered by mucosa, surrounds the nasopharyngeal orifice of the eustachian tube above and behind. The fossa of Rosenmuller lies above and behind the torus. The adenoid is situated on the roof and upper posterior wall of the nasopharynx.

Bands and small nodules of lymphoid tissue are scattered throughout the nasopharynx and pharynx, but are said to be more developed superiorly in the nasopharynx. The adenoid lies on the roof and upper posterior wall of the nasopharynx and may be extensive, encroaching upon the fossa of Rosenmuller and even extending over the torus tubarius.

Nasopharyngeal lymphoid tissue, which ordinarily undergoes some atrophy at time of puberty, may persist following infections. Close association of infected lymphoid tissue with the nose, sinuses, and eustachian tubes is a factor in frequent infections of these

structures.

The vertical and slit like ostium of the eustachian tube is normally closed, but is forced open by muscular action or positive pressure, thus equalizing the pressure within the nasopharynx and the middle ear. Normally, air exchange between the nasopharynx and the middle ear is very slow, since the normal tube may remain closed for long periods of time each day. Prolonged closure of the tube, as a result of infected or hyperplastic lymphoid tissue, leads to middle ear infection. Hypertrophied lymphoid tissue has been demonstrated, in cases of chronic infection, not only about the eustachian tube orifice, but also within the lumen of the tube and even within the middle ear. It has been observed, however, that this hypertrophied lymphoid tissue does not occlude the lumen as a foreign body might, but impairs proper aeration of the middle ear by edema of the tubal mucosa and excessive activity of the mucus glands within the tubes. This mechanism is thought to give rise to retrograde infection of the middle ear.

Normal nasopharyngeal lymphoid tissue, by filtering pathologic agents and producing antibodies, which are immediately available in the vicinity, serves as

an effective barrier against infection. Acutely infected lymphoid tissue, when irradiated, is known to release infectious and deleterious agents which gain access to the circulation. Thus the irradiation of normal or acutely infected lymphoid tissue of the nasopharynx must be avoided. It has been found that surgical removal of a large adenoid mass, followed by irradiation, is always more satisfactory than is irradiation alone.

Only a small minority of observers disagree with the opinion that properly administered irradiation of the nasopharynx is without serious side effects. The more serious of these side effects are pre-malignant change in the nasopharynx, ulcerations of the nasopharynx, and damage to the growing mandible.

The irradiation from the radium applicator falls off so rapidly with distance that it is effective only in treatment of hypertrophied lymphoid tissue in its immediate vicinity, and not for generalized lymphoid hypertrophy in the nasopharynx. Two well substantiated complaints against the radium applicator are that inaccurate placement of the applicator occurs frequently and that excessive dosage may be received at the surface of the tissue treated.

A well refuted criticism of roentgen ray therapy to the nasopharynx is that intervening tissue, which required no irradiation, might sustain damage.

Proponents of roentgen ray therapy point out that the hyperplastic lymphoid tissue of the nasopharynx and the eustachian tubes receive quite uniform irradiation, and that the surface tissue is not exposed to an excessive dosage.

Various studies on the effects of radium applicator or roentgen ray irradiation of the nasopharynx for deafness verify the considerable improvement in hearing of children with conductive type hearing loss, attributable to obstruction of the eustachian tubes, following irradiation. Somewhat less improvement is noted in adults with conductive type hearing losses. The necessity of audiometric tests, nasopharyngeal visualization, inspection of the auditory canals and the tympanic membrane, and treatment of concomitant allergic conditions before administering irradiation is indicated.

Children with asthma, associated with respiratory infections, who had received irradiation either by radium applicator or by roentgen ray, were shown in about 70% of the cases studies to obtain substantial

relief by this treatment. In children showing sensitivity to allergens other than bacterial products, hyposensitization to these other allergens was found to offer them additional benefits.

Recurrent otitis media shows great improvement when treated by the radium applicator, but chronic suppurative otitis media is quite unsuccessfully treated. Roentgen ray therapy also yields excellent results in the treatment of recurrent otitis media.

Recurrent colds and cough attributable to hyperplastic nasopharyngeal lymphoid tissue were reported to have shown marked improvement in 70% of a large series of cases in which roentgen irradiation to the nasopharynx had been performed.

CONCLUSIONS

1. Properly administered irradiation of the nasopharynx is without serious side effects.
2. Roentgen ray or radium applicator irradiation of the nasopharynx is of definite benefit in cases of conductive type hearing losses due to eustachian tube obstruction, particularly in children.
3. Roentgen ray is superior to the radium applicator for irradiation of hypertrophied or infected lymphoid

tissue of the nasopharynx.

4. Results of irradiation of the nasopharynx are improved by previous surgical removal of large masses of lymphoid tissue.

5. Allergic components, to other than bacterial allergens, of patients with conditions attributable to infected or hyperplastic lymphoid tissue of the nasopharynx, should be treated by hyposensitization previous to irradiation.

6. Asthmatic children, in whom some or all attacks are precipitated by respiratory infections, received significant symptomatic relief following irradiation of the nasopharynx.

7. Recurrent otitis media is treated successfully in a large proportion of the cases by irradiation of the nasopharynx.

8. Conductive type deafness, to be treated by irradiation, is best detected early, since middle ear changes become irreversible.

9. Irradiation of normal lymphoid tissue or acutely infected lymphoid tissue of the nasopharynx is definitely contraindicated. Normal lymphoid tissue is an effective barrier to infection, and acutely infected lymphoid tissue releases deleterious products into the circulation when irradiated.

10. Leukemia was not mentioned as a possible side effect of nasopharyngeal irradiation in any of the articles read during the preparation of this paper.

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