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Subtotal adrenalectomy for hypertension

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The unsatisfactory results of present day medical and surgical treatment of patients suffering with essential hypertension is well known to all students of the subject. Medical management has progressed little over a period of years and still consists primarily of palliative measures to alleviate the suffering of this group of patients. Each year presents the clinician with a myriad of new drugs intended to decrease the peripheral resistance of the vascular bed and the multiplicity of these agents speaks for their general lack of efficacy. The surgical approaches to the problem have for years been built on the hypothesis that overactivity of the sympathetic nervous system is in one way or the other responsible for this disease process. A review of past writings as well as testimonials by present investigators of this subject will show the primary problem in treating these patients, is a lack of understanding of the pathological physiology underlying this disorder.

The purpose of this paper is to evaluate a relatively new surgical procedure which appears to have a more physiological basis in light of our recent appreciation of the profound the multiple actions of the

secretions of the adrenal cortex. In view of the highly controversial nature of the etiology of Essential Hypertension, which is indeed a subject in itself, a detailed discussion of this subject will be avoided.

The hypotension of Addison's disease has stimulated many workers to speculate on the possible relation of the adrenal glands to hypertension. The early surgical methods were devoted to decreasing the secretions of the adrenal medulla, thereby lessening the adrenergic stimulation of the sympathetic nervous system. In recent years, particularly since the development of the pituitary-adrenal axis concept, the role of the adrenal gland has been investigated as to the cortical contributions to human physiology. Seyle (1), has probably been the leader in pointing out the role of the adrenal cortex in his work on the "General Adaptation Syndrome". Since that time, numerous investigators have changed their approach to solving the problem of Essential Hypertension. Goldblatt (2), Heinbecker (3), Schroeder (4), and Page (5), all make the adrenal gland a necessary link in their attempts to account for the pathogenesis of hypertension. It is not surprising then, to find that such a procedure as subtotal adrenalectomy is being adopted as an experimental treatment of this disorder in some medical centers.

The term subtotal as referred to in this paper is admittedly nebulous. This stems from the fact that many observers have failed to agree on the weight of the normal adrenal gland, hence no weight in grams for surgically removed tissue can be determined. Most authors feel they have performed a subtotal adrenalectomy when less than 15% of the functioning adrenal tissue remains intact. The term essential, in attempting to limit this discussion to essential hypertension, is equally vague in its meaning. The form of hypertension that is generally regarded as involving the hypothalamis-pituitary- adrenal axis, at least initially, is felt by many investigators to be neurogenic or essential hypertension. The role of the adrenal in other forms of hypertension such as arteriosclerotic, renal, endocrine, or "secondary" hypertension as recently classified by Schroeder (4), will not be discussed.

A review of the early literature written during the past twenty to thirty years, shows the thinking as to the etiology of essential hypertension and the resultant surgical approaches to the problem. As early as 1904, Jesue (6) made this observation, "If one envisages adrenalin as a product of secretion of the suprarenals, it is only one step further to think that these organs may play an important role in the production

of artheromatous lesions." It is interesting to note that forty-seven years later, Heinbecker (7) made this same statement at a meeting of the American Surgical Association. In 1929, Goldzieher (8) stated that after twenty years of close observation, "the basic disturbance in genuine hypertension is a hyperfunction of the adrenals and that this holds true not only for essential but also for the renal type of hypertension." At about this period, adrenal denervation was being popularized by Crile (9) as therapy for peptic ulcer, diabetes mellitus, hyperthyroidism, neurocirculatory asthenia, and hypertension. His rationale was to in effect remove the adrenal medulla from the sympathetic nervous system and thereby prevent "hyperadrenalemia". This condition and the resultant sympathetic over-activity were thought to be responsible for the above mentioned disease entities. Crile noted the marked rise in blood pressure while manipulating the adrenal gland at time of denervation. DeCourcy and DeCourcy (10) began treating essential hypertension with subtotal bilateral adrenalectomy in 1934. Again the surgical indication was the supposed hyperplasia of medullary tissue as the etiology of the disease. It is interesting to note that in the pathology report of one of their successful cases, hyperplasia of the adrenal cortex was reported

and yet their summary pointed to hyperplasia of the medulla as the significant pathological finding. DeCourcy (11) reported amazingly good results with the procedure at this time. Eight cases were operated and all were markedly improved. One case showed a blood pressure of 225/140, aphasia following a cerebral hemorrhage, and blindness in one eye prior to operation. Post-operative results showed a blood pressure of 150/110, with the patient walking out of the hospital in excellent health. Most of the patients were followed for some time and these authors felt they realized a definite cure. Crile (12) presented the results of fifty-two unilateral adrenalectomies, and two hundred fifty-six adrenal denervations in 1934. As stated before, only a portion of these cases were hypertensive patients. The unilateral adrenalectomy appeared to alter the course of the disease process very little, however the results of the adrenal denervations proved to Crile that hypertension found in younger patients was arrested by this surgical method. The relation of adrenal denervation to subtotal adrenalectomy may appear remote, yet it is not inconceivable that by the removal of sympathetic impulses to the adrenal medulla, the pituitary-adrenal cortical activity was lessened in these patients. Walters, Wilder, and Kepler (13)

reported one case of subtotal adrenalectomy in 1934. The details of the case were not presented, however the end result was reported successful. They also found hyperplasia of the adrenals in three necropsy studies of hypertensive patients. In 1935 DeCourcy (14) published a more detailed report on his work with subtotal adrenalectomy. He concluded that early diagnosis was imperative and utilized fundoscopic examinations, blood chemistry findings, and renal function tests as criteria for operating a patient. In properly selected cases his results continued to be excellent. At that time he was performing a two stage procedure with a three month interval, and removing four-fifths of each gland. He used the lumbar or retroperitoneal approach and noted the usual drop in blood pressure was 100 points systolic and 40 points diastolic. The temperature rose to 103 and returned to normal in six days. Arteriosclerotics operated on showed little drop in blood pressure but great subjective improvement. From 1935 up until the last two years, I was unable to find any reports on this procedure. It seems strange that the procedure was not carried on and developed after these early favorable reports, however all of the recent investigators comment on the inaccuracy and lack of detail of the literature written earlier on the

subject. Another possible explanation is the great popularity enjoyed by various types of sympathectomies starting about 1935 and only recently being discarded or combined with adrenalectomy in the treatment of hypertension by many workers.

As has been noted, all forms of adrenal surgery for hypertension up until 1935 were performed with the purpose of decreasing the secretions of the adrenal medulla, thereby reducing the level of epinepherine and nor-epinepherine in the blood stream. Although many research men such as Goldblatt (15) proved the adrenal medulla not directly responsible for essential hypertension, the lack of knowledge of the action of the adrenal steroids and the role of these steroids in the pathogenesis of hypertension, left these early workers no other conclusion from their successful adrenal surgery. It is probable that such a stumbling block contributed to the obscurity of this procedure until 1949. In 1937, Goldblatt (15) stated he felt the adrenal cortex was an important feature in the mechanism of essential hypertension, but the results of his work showed subtotal adrenalectomy to be impractical due to the lack of an adequate substitution therapy regime. At this time he was using aqueous cortical extracts. Page (16), reported these same findings in 1938.

As mentioned previously, Seyle (1) undoubtedly gave more impetus to the role of the adrenal cortex in essential hypertension than any other single individual. His hypothesis that stimulation of the sympathetic nervous system causes the discharge of epinepherine into the blood stream, and the subsequent hypothalamic action on the pituitary causes adrenal cortical secretion by trophic stimulation, is still the basis of most of the theoretical considerations now being tested. Many authors have now recognized this role of the adrenal cortex in essential hypertension, but the exact mechanism is still a matter of conjecture. Seyle (17) himself has proposed that a disturbance in the so-called mineralo-gluce corticoid ratio of adrenal cortical secretions may be of prime importance. He proposes that when the mineralocorticoids (desoxycorticosterone) are increased, there may be increased production and decreased destruction of R.P.S. (Renal Pressor Substance). Heinbecker (18) in 1947, reported that the pathogenesis of essential hypertension was due to, "a hypophyseal over-reaction with resultant trophic stimulation of the adrenal cortex due to a functional depression of the hypothalamic nuclei innervating the neural hypophysis." He felt if a constitutional susceptibility of the hypothalamus to depression existed, then the combined influence of

eosin-cell-adrenal cortical hormone is to constrict the efferent glomerular arterioles and result in release of renin. Many investigators have taken the now available adrenal cortical fractions and have experimentally attempted to produce hypertension in animals. Only DOCA appears to possess "pressor" qualities, with the mechanism involved in dispute. Some authors find this substance to have pressor qualities in conjunction with a normal diet, while others report the necessity of large doses of salt along with the DOCA administration to substantiate these findings. Seyle (19) demonstrated that DOCA to be capable of producing hypertension and its associated cardiac and renal lesions in the salt-fed rat. Green and his co-workers (20) showed DOCA to be capable of producing hypertension on a normal diet. In a later publication, Green (21) found only traces of DOCA in human adrenals and concluded that other undiscovered salt retaining steroids with pressor activities must be present. He reasons a salt-retaining hormone is responsible, due to the sensitivity of hypertensive patients to variations in sodium intake. Perera (22) followed a hypertensive patient who developed Addison's disease and showed that adequate salt and DOCA administration resulted in hypertensive blood pressure levels. He feels that hypertensives

may be overly-sensitive to DOCA. Two recent publications are of interest and add to the confusion in this problem. Zintel and his group (23) were unable to prove that DOCA was more pressor than the other adrenal cortical steroids. In keeping with this thought, Heinbecker (7) has recently stated he feels overaction of the adrenal cortex is not essential in the pathogenesis of essential hypertension. As one can readily see, the mechanism of the adrenal cortex in the pathogenesis of essential hypertension is a long way from being understood. However, many investigators do appear to accept the hypothamic-pituitary-adrenal axis theory and most are in agreement that the adrenal medulla is not of prime importance in this disease process. In view of these facts and in view of the excellent results of subtotal adrenalectomy in the hands of some operators prior to 1935, as well as during the past three years, we can only conclude that the adrenal cortex does appear to be an intricate part of the mechanism of hypertension. The availability of the adrenal cortical steroids in a more purified form than the raw cortical extract, has and will contribute to the study of this problem. The subtotal adrenalectomies performed in the last few years have had the advantage of these compounds in their substitution therapy and, as will be seen, the

post-operative management of cases is now greatly simplified in contrast to previous years.

The indications for this procedure, as proposed by those surgical teams performing the procedure in the last few years, are somewhat contradictory. Crile (9) found in his denervation series, that young adults whose hypertension had been detected early were the best candidates for the procedure. He also noted that older people received equal subjective improvement but were not aided a great deal objectively. DeCourcy (14) in 1935, felt that early diagnosis was imperative and only operated patients with no retinal changes and completely normal renal function tests. Neuhof (24) in 1948 operated only on patients with severe hypertension that had not been permanently improved with sympathectomy. Green (21) has also reserved this procedure for hopeless cases only. In opposition to this recent trend of using this procedure as a last resort measure, Heinbecker believes the early reduction of adrenal-cortical tissue will do more good in treating hypertensives because of the steroids contribution to arteriosclerosis by altering normal neutral fat and lipid metabolism. As can be seen, no clear cut indications for the procedure have been laid down by recent workers. The highly experimental position of this

procedure has and probably will be to prolong life for a short period of time. It is probable however, that as more procedures are performed, the usage of this approach earlier in the disease will again be resorted to, with increasingly favorable results.

The surgical technique currently employed by Zintel and his group (26), seems to be the procedure accepted by most authorities. In their two-stage operation, they first expose the adrenal gland through a lateral subcostal incision with the patient in a lateral decubitus position. The kidney rest or kidney bar of the operating table is placed three inches cephalad to the lowest point of the costal margin. They have not found it necessary to remove the twelfth rib. The perinephric "space" is entered by blunt dissection and the adrenal gland is then easily located by following the parietal peritoneum to the inferior vena cava at the level of the attachment of the diaphragm to the posterior body wall. Only one large vessel, the adrenal vein, is found attached to the gland. On the right side, this vessel is very short and emties directly into the inferior vena cava. On the left side, the adrenal vein joins with a vein from the diaphragm and then empties into the renal vein, or inferior vena cava. The arteries of the adrenal gland apparently divide

into numerous arterioles which enter the perpheral edge of the gland. They usually find no significant arterial bleeding in separating the peripheral edge of the gland from the surrounding structures by sharp dissection. The flat surfaces of the gland are easily separated from the surrounding tissue by blunt dissection. When a remnant of the gland is to be left in situ, it is left at the point of exit of the adrenal vein. The remnant is separated from the surrounding structures only sufficiently to estimate its size. Originally they left some adrenal tissue on both sides, however recently they have been leaving a remnant on the first side only and performing a total adrenalectomy on the second side. Hemorrhage is controlled by silver clips or fine catgut sutures. These authors stress the importance of the presence of an anesthesiologist familiar with proper methods of maintaining the blood pressure levels during the procedure and at the same time avoiding heart failure in those patients on the verge of that condition.

The reported results of subtotal adrenalectomy, beginning with DeCourcy's (10) series of eight cases in 1934, show a respectable percentage of successful procedures. Although his cases were not reported in sufficient detail for critical analysis, DeCourcy

found all patients to have a reduction to near normal levels of both systolic and diastolic blood pressure. Complete disappearance of subjective symptoms was also noted in these patients. Walters, Wilder, and Kepler (13) reported one case of essential hypertension in the malignant phase to have been cured by this procedure. Langeror, Vincent, and Desorcher (27) offered their series of twenty cases as proof that this procedure was effective. Recent investigators who have reported their cases begin with Neuhof (24), who in 1948 reported fourteen cases in which subtotal adrenalectomy was employed either in conjunction with semilunar sympathectomy or following failure of this procedure. The patients operated were all of the severest grade of hypertension with blood pressure readings between 250-300 systolic and 150-190 diastolic. One case was a complete failure but was found at autopsy to have generalized arteriosclerosis of the adrenal glands. The other thirteen cases showed pronounced reduction in blood pressure, which was apparently permanent. Three additional cases of bilateral adrenalectomy alone revealed highly successful outcomes, and one only moderately so. Neuhof concluded, "The influence of bilateral hemiadrenalectomy on blood pressure appears to be so salutary as well as distinctive that

the question of employing this procedure along for hypertension appears parallel to subtotal thyroidectomy for Graves disease. DeCourcy (28) reported his series of thirty cases in 1950. There was no mortality in this series and all patients operated upon reported marked subjective improvement. In 75% of the cases, DeCourcy found significant reduction of blood pressure. This group of patients includes some under observation for ten years who showed no return of their hypertension in that time interval. Wertheimer and Lecuire (29) recommend adrenalectomy on the basis of twenty-two successfully managed cases, employing this procedure. Green and his group (21) reported a spectacular case in 1950, in which they treated a twenty-eight year old white female by a two stage subtotal adrenalectomy. This patient gave a history of eight years of hypertension, the last two of which she had suffered headaches, nervousness, flushing, blindness in one eye, ankle edema, dyspnea, and pre-cordial pain. She had been a diabetic since six years of age and showed a blood sugar of 800 mg% pre-operatively. Her blood pressure was 270/140 and heart enlargement estimated at 15%. Phenolsufonephthalein test showed 44% total elimination in two hours. 95% of the patient's left adrenal gland was removed and two months later a

complete adrenalectomy on the opposite side was performed. The post-operative results showed complete alleviation of subjective complaints, including marked improvement in vision. The heart size and Electrocardiograph returned to normal and the blood pressure was reduced to 120/70. PSP was 59% in two hours and the blood sugar taken in a fasting state, was 98 mg% on 24 units of insulin daily. These authors feel that Addison's disease resulted from their treatment and do not recommend the procedure for either malignant hypertension or diabetes. They feel this procedure should be reserved for "hopeless" cases only. Thorn, Harrison and Criscitilla (6) working as a team, reported to Huggins and Bergenstal (7) by direct communication, the results of twelve patients treated with subtotal adrenalectomy. Out of these twelve cases, eight survived and four received great symptomatic relief with significant reduction in blood pressure. Zintel (25) and his group have reported a group of twenty-five patients treated with either subtotal adrenalectomy (eleven), total adrenalectomy (two), or a combination of adrenalectomy with sympathectomy (eleven). In this latter group of patients, 15% of the adrenal tissue was left intact. Pre-operatively these patients were refractory to all forms of medical management and showed an average

blood pressure of 232/147. Of the thirteen patients treated with subtotal adrenalectomy, eleven have been followed from five months to one year. Three of this group have died. The remaining eight have had subjective improvement and have returned to unrestricted activity. Three of the group now have normal electrocardiographs, four have decreased heart size and three show improved eye grounds. Six out of the eight patients have a moderate increase in pigmentation. Renal function has improved markedly in all patients as indicated by the increase in plasma flow through the efferent glomerular vessels. As a conclusion to this series, Zintel feels that the adrenal is more important to hypertension than the sympathetic nervous system. They also noted that with frank adrenal insufficiency, the hypertension returned.

The improved understanding of the physiology of the human adrenal gland and the avai ability of steroid hormones, especially DOCA and cortisone, have revolutionized the management of patients after adrenal operations. Prior to a discussion of the actual therapy employed, it should be stated that all authorities are in agreement that substitution therapy is not necessary following the removal of all of or a portion of one adrenal gland. The employment of substitution or

replacement therapy is considered essential by the majority of recent workers after removal of all or part of the second adrenal, in order to provide protection from frank adrenal insufficiency. This condition is rarely compensated for when it occurs in these patients. Earlier writers, (Crile, DeCourcy, and Neuhof) make no mention of post-operative therapy following subtotal adrenalectomy. This I feel can only be explained by Zintel's conclusion in his review of the literature. He feels that most of the early workers resected only about 60% of the adrenal cortical tissue, whereas most recent workers have been resecting 90-95% of this tissue. Goldzieher (8) and many other workers have shown that one-fourth of one adrenal gland is sufficient to maintain life and health in an animal, therefore it can be understood why the earlier workers needed no replacement therapy in the patients. DeCourcy (28) is the only investigator who has found replacement therapy unnecessary in his recently reported series of thirty cases. The reason for his findings are obscure. However, in noting that only 75% of his patients have received reduction in blood pressure post-operatively, one might wonder if he is removing as much adrenal tissue as he approximates. The small segment of functioning adrenal tissue remaining post-operatively in

most patients, is believed by the majority of investigators to be inadequate to sustain life in these patients and death results from frank adrenal insufficiency. This condition is characterized by gross electrolyte imbalance and resultant fluid derangement, hypoglycemic shock, marked hypotension and eventual secondary shock. Huggins and Bergenstal (7) emphasize the importance of forestalling adrenal insufficiency and recommend treatment of the patient in advance as if insufficiency were inevitable. They then withdraw the essential medication slowly in the post-operative period. The most important factors in their routine are adequate individualized quantities of cortisone, DOCA, post-operative blood transfusions to replace that lost and maintenance of systolic blood pressure above 100 by slow intravenous injection of vasopressor agents such as l-norepinepherine. They feel massive doses of intravenous fluids are harmful and that the total injected fluid on the first post-operative day should not exceed 1,500 cc. Aspirin (.6gm orally) is given to reduce the temperature elevation commonly seen post-operatively. The maintenance dosage of cortisone (25-50 mg/day orally) is usually instituted on the sixth post-operative day along with supplemental ingestion of 2-4 gm of sodium chloride daily. DOCA has not been needed in their patients. Zintel (26) favors

the Thorn regime for his patients. This consists of 10mg of ACTH intramuscularly every six hours for forty-eight hours pre-operatively; 100 mg of cortisone intramuscularly on the day of operation and the first post-operative day, and 50 mg orally on the second and third post-operative day. Thereafter sodium chloride, DOCA, and cortisone are given as needed by the patient. These authors also state that the urgent immediate need in post-operative management of these patients is a substance with all of the properties of cortisone save for its blood pressure elevating effect in hypertensive patients. Scarcely less important is the need for simplification of tests to detect adrenal insufficiency early. All authors have observed the difficulty in predicting impending adrenal insufficiency in these patients.

A critical evaluation of the reported results of this procedure is difficult due to the previously mentioned paucity of detail in the reported cases. As we have seen in previous paragraphs, the testimonials of these investigators now employing this procedure are encouraging. Green and his group (21), although contributing some information on a theoretical level, contribute little to the over-all picture by relegating the procedure to the "hopeless cases only" group on the

basis of their one case. This attitude is confusing due to the marked improvement shown by their patient. Most investigators are understandably hesitant to be commital on a procedure so experimental in nature and this fact contributes to the difficulty in analyzing the results. DeCourcy (11) has advocated this procedure since 1934, and is enthusiastic in his support. As we have noted previously, his work requires more detailed reporting before his conclusions can be accepted. The fact that none of his patients have required substitution therapy, that he has had no mortalities, and that 75% of the patients have received reduction in blood pressure, differs from other workers findings. However, we also note that DeCourcy is one of the few workers who insists upon operating patients with essential hypertension before any retinal or renal pathology is present. This necessarily means he is operating a younger group of patients with hypertension of shorter duration. It is understandable why his mortality is lower if such be the case. Also, we can theorize that substitution therapy is not needed due to a greater functional capacity of the adrenal remnant in these younger patients. These adrenal glands have not been subjected to as much stress and possibly even to fewer arteriosclerotic changes than the glands in hypertensives

of longer standing. The results of Neuhof (24), Zintel (26), and Huggins and Bergenstal (7) have all been encouraging, but in each report we find unexplained mortalities and lack of detail in those cases that failed. The mortalities are undoubtedly contributed to by the choice of "otherwise intractable cases". Zintel's mortality of three out of nine patients, four out of nine in Thorn's series is confusing in view of DeCourcy's results. Due to the lack of elaboration, we can conclude only that the advanced stage of the disease with its devastating sequelae was influential in these cases.

While examining those cases that have survived operation and have failed, we note that Zintel (26) has proposed adrenal regeneration as a possible cause for this result. This phenomenon has long been observed in the remaining adrenal gland when one gland has been removed at previous operation. The frequency of occurrence of regeneration appears to be small. Heinbecker (7) has recently attempted to explain this process as follows; "If the adrenals are totally removed, the anterior pituitary changes its histological pattern and function in a manner which would not stimulate excess regeneration of adrenal tissue. If a considerable remnant of adrenal tissue is left, the cytology and the function of the anterior lobe changes in

a manner which facilitates regeneration." It seems logical in view of this report, that if regeneration does occur, the operator may have failed to remove adequate adrenal tissue to induce the above-mentioned pituitary changes. Survival of the portion of gland left behind in the procedure does not appear to be a problem, providing that remnant left is insured adequate blood supply.

Comparing the successful cases of all authors, we find unanimity in their reports. Alleviation of subjective complaints, reversal of cardiac and retinal pathology, increased plasma flow through efferent glomerular vessels, and marked, permanent reduction in blood pressure appear to result. We find most patients are in need of some form of post-operative substitution therapy, which is now more easily obtainable and administered.

The most consistently omitted material in the papers reviewed, was that describing the histopathological appearance of the adrenal tissue removed. It seems that this information would be of considerable import to investigators working on the etiology of essential hypertension. Undoubtedly all surgical specimens were examined, and it is possible that normal adrenal tissue was found in most cases, therefore comment

was not felt necessary. However, Zintel and his group (25) report one-third of the twenty-five adrenal specimens to show nodular hyperplasia, two with cortical adenomata, and the others to be normal in appearance. They found the average weight of these glands to be 6.12 grams. These findings return us again to the turmoil of the pathogenesis of essential hypertension. With no consistent evidence of cortical hyperplasia, it appears Heinbecker's recent statement that overaction of the adrenal cortex is not necessary in the pathogenesis of essential hypertension may be correct. In any event, whatever may ultimately be found to be the exact etiological factor or factors in this disease, we cannot exclude the adrenal gland as an important link in the chain. The striking success of many subtotal adrenalectomies appears to demand our focus on the adrenal gland in the future treatment of this disease process.

SUMMARY

We have seen that subtotal adrenalectomy has not been developed recently but stems from earlier surgical techniques and is currently being revived in light of our greater understanding of adrenal physiology. We have noted that many investigators feel the adrenal cortex to be implicated in one way or another in the pathogenesis of essential hypertension. A review of the reported cases reveals numerous exceptional results in permanently arresting the course of this disease process. The majority of cases show a regression of secondary pathology resulting from the hypertension. The employment of this procedure in advanced, otherwise intractable cases of long standing, as is now the policy, offers many problems in analysis of reported mortality. We have seen how the availability of adrenal cortical steriods for substitution therapy has made the post-operative management of these patients relatively simple.

It is well known that many patients will live their complete life span with moderately elevated blood pressures apparently due to essential hypertension, and suffer relatively little. It is not for this group of patients that this procedure appears intended. It does

seem however, that those patients plagued by the distressing discomfort of the renal, retinal, and cardiac complication of this disease process, can be spared this suffering early in the disease by a subtotal bilateral adrenalectomy. All evidence points to a low mortality in younger patients with the disease process of shorter duration. Post-operative management is apparently highly successful and the relief of symptoms and arrest of the disease in the hands of competent surgeons, seems to be nearly complete and permanent. From an objective standpoint then, it is difficult to appreciate any hesitancy on the part of a physician to employ this procedure on patients suffering from the mutiple complications of essential hypertension.

CONCLUSION

1. The use of subtotal adrenalectomy in the treatment of essential hypertension is increasing each year, and the results of the procedure are becoming more consistently successful.

2. Post-operative substitution therapy no longer appears to be an obstacle in managing these patients.

3. The permanent, successful arrest of this disease process following this surgical procedure, demands further study of the role of the adrenal cortex in the pathogenesis of essential hypertension.

4. Selection of younger patients with hypertension of shorter duration, and less severe secondary pathology, will probably reduce the mortality rate now reported by some investigators.

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