NEUROSURGICAL ALLEVIATION OF PARKINSONISM*

IRVING S. COOPER

Assistant Professor of Neurosurgery, New York University Post-Graduate Medical School; Director, Department of Neurosurgery, St. Barnabas Hospital.

I AM very grateful for the invitation to take part in this Graduate Fortnight which is concerned with the problem of geriatrics and chronic diseases. The Committee has asked me to review briefly the current status of the neurosurgical therapy of parkinsonism and to demonstrate and comment upon the results which have been achieved in our own investigation into this problem. These remarks supplement the technical exhibit on neurosurgical therapy of parkinsonism which has been on display during the Fortnight.

Since 1817 when James Parkinson described the syndrome of the shaking palsy which bears his name, there has been a sustained interest in developing new methods of therapy for this affliction. This interest has thus far resulted in little concrete progress toward the development of a specific medicinal agent which will either eliminate the disabling symptoms of parkinsonism or halt its inexorable course once the first sign of shaking palsy has made its appearance. Thus, in our present state of knowledge the progress of parkinsonian tremor and rigidity and gait abnormalities, as well as the other stigmata of parkinsonism, is usually relentless and inevitable. The average patient will usually reach a lingering stage of almost total helplessness; speechless, expressionless, unable to move at will but constantly shaking from involuntary tremor, and held in a prison of his own rigid musculature.

It is this invariably pessimistic prognosis that has led some patients to submit to brain surgery in the hope of a degree of alleviation from their symptoms, and has led some neurosurgeons to attempt procedures for such alleviation. It is the purpose of this discussion tonight to review briefly the procedures which have been attempted by neurosurgeons up to the present time and to describe specifically two original tech-

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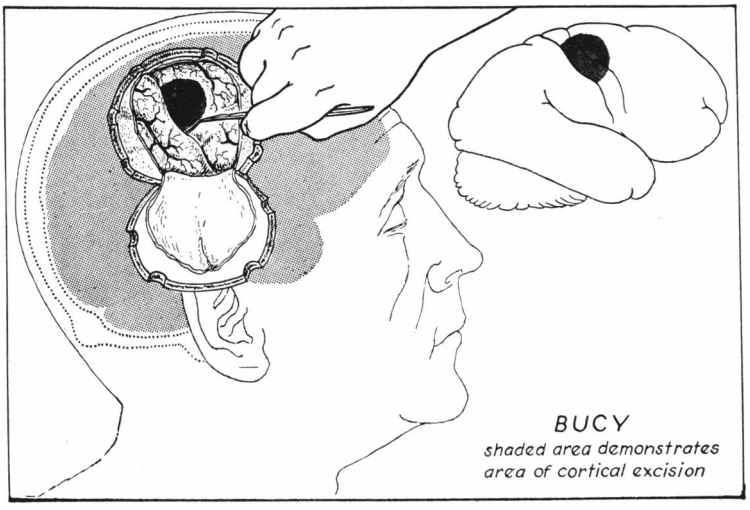

Fig. 1.—Demonstration of Bucy's cortical excision operation for parkinsonian tremor. This procedure results in contralateral hemiplegia or hemiparesis with resultant lessening or abolition of tremor.

niques which have been employed in a series of 145 cases, on our own service. It is my opinion that neurosurgical therapy has reached a stage where it may be considered a reasonably safe, practical, and useful tool for the treatment of many cases of parkinsonism. I should like to present some of the results of such treatment during the course of this presentation tonight.

Review of Neurosurgical Approaches to Parkinsonism

The Pyramidal Tract Operations: During the past two decades, neurosurgeons have devised operations at virtually every level of the nervous system during their attempts to alleviate some of the tedious symptoms of parkinsonism. Most of the early efforts consisted of destructive lesions of the pyramidal tract. Neurosurgical operations of the cerebral cortex for involuntary movements were originated by Horsley,[1] who excised the precentral cortex in cases of athetosis as early as 1890. Operations which were devised to resect either the premotor cerebral cortex (area 6) or motor cerebral cortex (area 4) were introduced by Klemme[2] and by Bucy,[3] approximately 20 years ago. Bucy states that cortical extirpation is most effective when it includes cortical area 4 and 6 of Brodman (Fig. 1). This operation

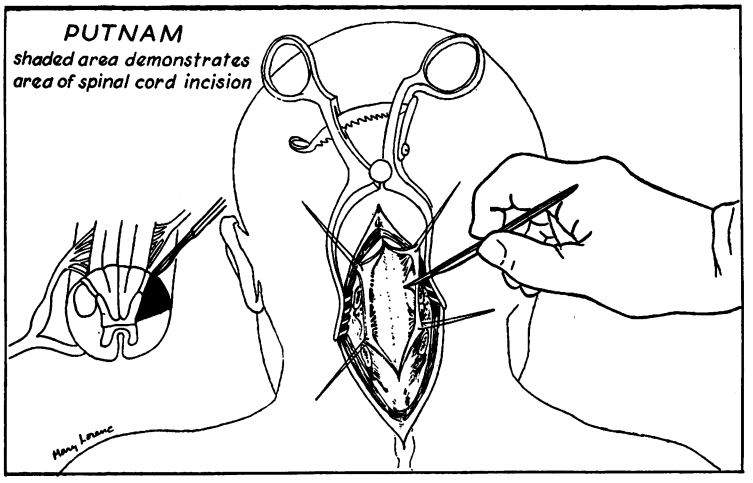

Fig. 2.—Transsection of the pyramidal tract in cervical spinal cord as advocated by Putnam. This operation produces an ipsilateral hemiparesis with proportional reduction of tremor. Rigidity is unaffected.

produces a contralateral hemiplegia which subsequently lessens in severity leaving the patient with a residual hemiparesis but without tremor. Epileptiform seizures may develop following this operation. Rigidity and incapacitation are not decreased and may, in fact, be increased by cortical extirpation.

As a result of his investigation Bucy stated:

> "Nothing in my experience leads me to believe that it is possible to abolish tremor by any procedure which does not interrupt the pyramidal tract or destroy that portion of it which arises from the precentral gyrus."

This conclusion stimulated others to attack the pyramidal tract at levels below the cortex. Putnam[4] devised the operation of pyramidotomy which consists of incision of the pyramidal tract at the level of the second cervical segment of the spinal cord (Fig. 2). Ebin[5] and Oliver[6] have devised modifications of spinal pyramidotomy. Walker[7] has devised an operation upon the pyramidal tract in the cervical peduncle. This operation is referred to as pedunculotomy. According to Walker, a compromise with paralysis and freedom from tremor is the best that can be expected from pedunculotomy or from other operations aimed at the pyramidal tract, either at the cortical or spinal cord level. Such operations were devised solely to relieve tremor and they succeed in

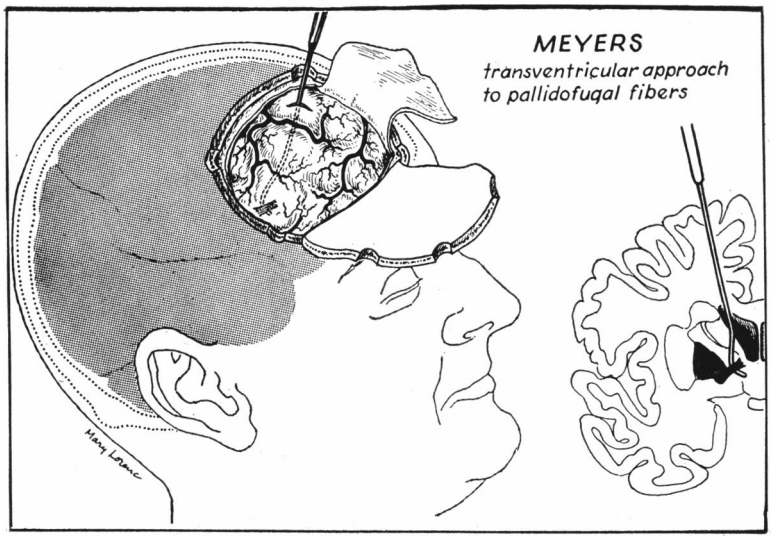

Fig. 3.—Transventricular approach of Meyers to the pallidofugal fibers. This operation was one of the first approaches to surgery of the basal ganglia and demonstrated that tremor and rigidity could be alleviated without necessarily producing loss of motor power.

this aim only at the expense of motor power. It has since been demonstrated that tremor can be relieved without necessarily sacrificing motor power. Thus, there is rarely, if ever, at the present time, any indication for purposeful destruction of the pyramidal tract in the treatment of parkinsonism.

Basal Ganglia Operations: A more profitable neurosurgical target in cases of shaking palsy is the region of the basal ganglia. A major advance in the surgical therapy of parkinsonism was the investigation of Meyers in the surgery of the basal ganglia. Since 1940, Meyers[8] has experimented with various operations among which are: 1) extirpation of the head of the caudate nucleus and interruption of fibers in the oral portion of the anterior limb of the internal capsule; 2) extirpation of the head of the caudate nucleus and the oral one-third of the globus pallidus and putamen; and 3) section of the pallidofugal fibers emerging from the mesial globus pallidus. Meyers has said that "for each of these procedures, it has been possible to demonstate an obvious improvement with respect to tremor and rigidity." He considers pallidofugal section the most effective of these three operations (Fig. 3). Meyers' experience

convinced him that the risks are too great to warrant the general use of transventricular operations in parkinsonism. However, even though Meyers does not recommend his transventricular operation for general use in neurosurgical clinics, his work introduced new concepts into the surgery of parkinsonism.

Browder[9] has developed a modification of Meyers' transventricular operation which he calls the capsular operation. This operation reduces tremor and also to some extent rigidity. Although it initially produces a paralysis of the extremities, Browder states that the paralysis largely disappears although the patient subsequently "shows a lack of interest in using the hand." Browder concludes that fully 90 per cent of patients with parkinsonism are excluded as candidates for this procedure.

In recent years, other basal ganglia operations have been devised. Spiegel and Wycis[10] have produced electrolytic lesions in the pallidofugal fibers by employing a stereotactic apparatus which they develop for operations on the human brain. Narabayashi[11] has devised his own stereotactic instrument to inject procaine in oil into the globus pallidus. Fénelon[12] has devised a direct method for "sub-pallidal" or ansa lenticularis coagulation without use of a stereotactic instrument or roentgenographic control. Guiot and Brion[13] have also carried out direct coagulation of the mesial globus pallidus and ansa lenticularis principally by an opened subfrontal operation. Each of these investigators has reported the alleviation of tremor and rigidity without necessarily inflicting a pyramidal tract lesion or paralysis upon the patient. Detailed and documented long-term follow-up studies of these cases will eventually help to evaluate what assets or deficits each particular technique may have. It is not unlikely that various neurosurgeons will be able to approach the region of the basal ganglia with salutary results employing various techniques. A further period of objective evaluation and perfection of techniques is the only way in which this matter can be clarified.

During the past three years, two original techniques have been developed on our neurosurgical service and have thus far been employed in a personal series of 145 cases.[14-17] I should like to briefly describe each of these techniques, list our current results and to present motion pictures of some of our longer term follow-up cases. In addition, one of the patients who appears in the motion picture is here tonight and will be presented for your own evaluation.

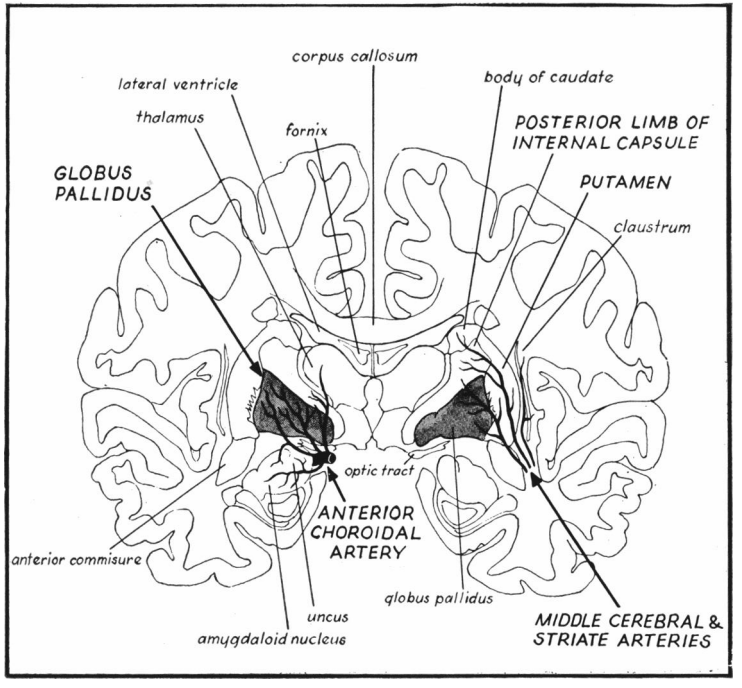

Fig. 4. (a) Illustration of the role of the anterior choroidal artery in the blood supply of the mesial globus pallidus.

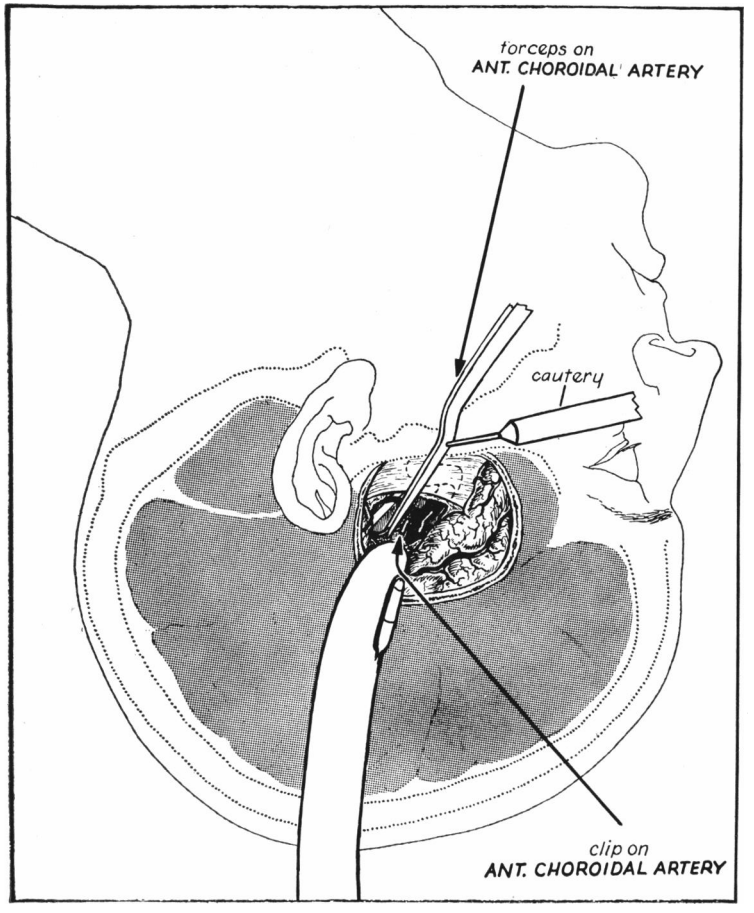

Fig. 4. (b) Surgical approach to occlusion of the anterior choroidal artery. This operation is performed in order to infarct the mesial globus pallidus and certain of its efferent connections.

Surgical Occlusion of the Anterior Choroidal Artery

The anterior choroidal artery has been demonstrated by Abbie to be the principal source of blood supply for the mesial part of the globus pallidus and its efferent connections through the ansa lenticularis with the corpus subthalamicum, ventrolateral nucleus of the thalamus, substantia nigra, and red nucleus. Abbie stated that these structures together with the anterior choroidal artery developed phylogenetically as a "functional unit." It has been our hypothesis that occlusion of the anterior choroidal artery might destroy the mesial globus pallidus, as well as certain other parts of this functional unit. Our surgical investigation has been based upon this hypothesis which was developed subsequent to one case in which the anterior choroidal artery was unintentionally sacrificed.

The surgical details of occlusion of the anterior choroidal artery have been described elsewhere and need not be repeated tonight. The operation can be briefly visualized in the accompanying figure (Fig. 4 a and b).

During the past three years, anterior choroidal artery occlusion has been performed on our own service 55 times. The mortality rate is 10 per cent. There were three cases of hemiplegia. Seventy per cent of the patients in the series demonstrated good results which have persisted up to the present time. This signifies virtual alleviation of tremor and rigidity of the extremities contralateral to the operation without any sacrifice of motor power. In addition, in several instances, there was noted marked improvement in masked facies, gait, speed of voluntary acts and reversal of previous fixed deformities. The operation of anterior choroidal artery occlusion should be limited to patients under the age of 55 with long-standing parkinsonian symptomatology and incapacitation.

Chemopallidectomy

In our search for a neurosurgical technique which could be used not only in young parkinsonian patients but also in geriatric parkinsonians, we have developed a procedure now referred to as chemopallidectomy.[17] This technique too has been described in detail elsewhere and will not be elaborated upon tonight. The fundamental aspects of the procedure can be seen in the accompanying figure (Fig. 5).

In brief, we have developed a relatively simple method for introduc-

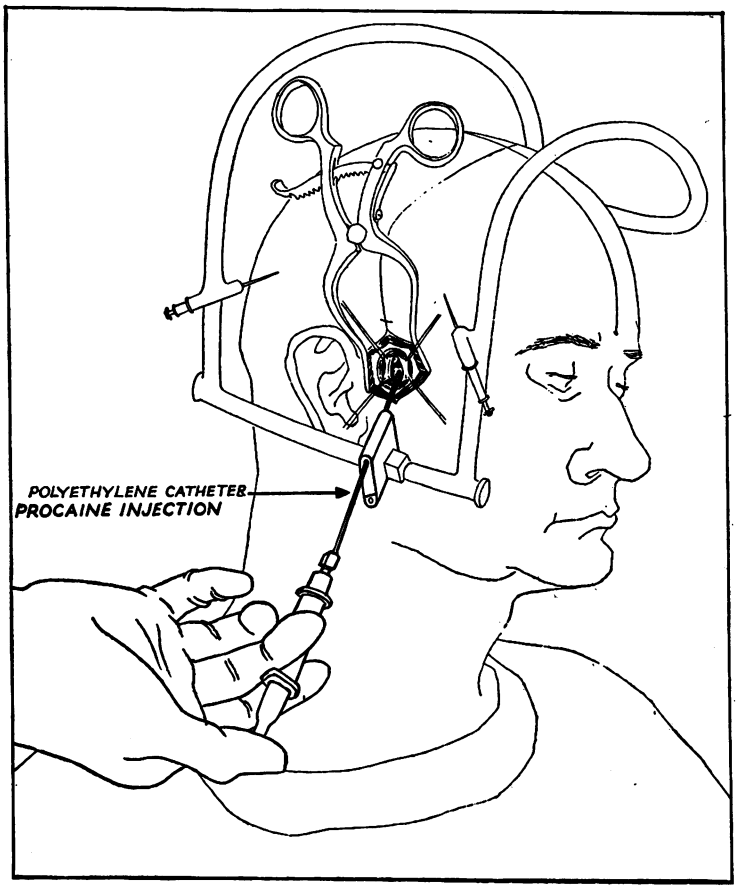

Fig. 5.—Demonstration of pallidectomy guide used during the operation of chemopallidectomy. With polyethylene catheter in the mesial globus pallidus, procaine is injected to determine effect of a lesion in this region upon contralateral tremor and rigidity.

tion of a small polyethylene catheter, either directly by hand or with the aid of a simple six-ounce needle guide we have developed, into the region of the mesial globus pallidus. Procaine is then injected into this region. In this way, the particular site is located, procainization of which will abolish tremor and rigidity of the contralateral extremities. Once the correct site has thus been localized, more lasting results can be achieved by producing a destructive lesion in the same area. We have experimented with several different ways of producing this destructive lesion including electrolysis, radio-frequency current, projection of a small knife blade into the region and injection of absolute

alcohol. The best results which we have obtained thus far have been with absolute alcohol. We are currently employing a solution containing 8 per cent celloidin in 95 per cent ethanol. This solution has the neurolytic properties of absolute alcohol but is viscous and very easily controllable during injection into the brain. Others are currently investigating the use of a small radioactive bead and ultrasonic vibrations to produce intracerebral destructive lesions. Each of these appears to have great potential merit and undoubtedly many technical improvements in all techniques will be forthcoming.

The operation of chemopallidectomy has been performed 90 times. The mortality rate up to this time is 3.3 per cent. Two cases have been complicated by hemiparesis. Seventy per cent of the cases now show good results during the follow-up period of this study. That is, since the time of operation these patients have had alleviation of tremor and rigidity in the opposite extremities. The longest follow-up period for chemopallidectomy is now 18 months, whereas some cases have been followed for three years in the series of patients who have undergone anterior choroidal artery occlusion. The operation of chemopallidectomy has now been employed in many patients between the age of 60 and 65. The operation is tolerated well by selected patients in this older age group and is, as far as I can determine, the first neurosurgical approach which can be used with a reasonable degree of safety in patients in the seventh decade of life.

Rather than describe in further detail the results which have been obtained, I should like to show a motion picture showing six patients before and after operation. The first three patients have been subjected to anterior choroidal artery occlusion and are shown preoperatively and again at various periods up to two years following operation. The second three patients have been subjected to chemopallidectomy and are demonstrated preoperatively and one year postoperatively. It is seen in this film that all of these cases have remained free of tremor and rigidity since the time of surgery and are able to function virtually normally with extremities which were previously incapacitated by tremor and rigidity.

The last patient, a 39-year old man, who, as you have seen in the preceding film, had marked tremor, rigidity and a dystonic deformity of the right extremities for 18 years prior to operation, is here tonight. Since the best way to evaluate any surgical procedure is by evaluating

the results, I have asked this patient to be present so that he could be examined and evaluated personally. As you can see, he is now entirely free of tremor and rigidity of the right extremities and presents no stigmata of parkinsonism. Both arms swing automatically while walking. This patient has gained thirty pounds since operation, and although he had not worked for seven years preceding surgery, he has since been able to return to gainful employment.

The Present Status of Neurosurgical Therapy

It is my opinion, as stated previously, that neurosurgical therapy of parkinsonism has now reached the stage in which it can be considered as a practical, useful, reasonably safe, and rewarding method of therapy in many instances of carefully selected, advanced cases of parkinsonism. However, this is not to say that surgery should be considered in every case of parkinsonism or that it will be successful in every case which is selected for operation.

Certain important scientific steps must be taken in order for neurosurgical techniques in parkinsonism to serve the useful and essential role in the therapy of this disease of which it is potentially capable. These steps are:

1. A new physiologic, diagnostic evaluation of patients with this syndrome. Since parkinsonism is merely a complex of a group of symptoms, a more descriptive and physiologic nomenclature is needed in evaluating each case. Neurosurgical therapy is aimed at specific symptoms and signs of the complex. Therefore, before any patient can be considered as a candidate for neurosurgical therapy, the individual signs and symptoms in that particular case must be carefully assessed, in a more specific way than has heretofore been the rule.

2. An objective, scientific evaluation of the results obtained by various techniques must be forthcoming. So much of the medical literature regarding the possibilities of various therapies for parkinsonism has been beclouded by statements which are not supported by fact, that it is particularly essential that this type of case be assessed in as scientific a manner as possible. To this end, I have arranged for the cases in my own investigation to be examined and appraised objectively by two groups who have not played a part in the development of these particular neurosurgical techniques. Dr. Leonard Diller and his associates are compiling a separate statistical follow-up study on all the patients

who have been operated upon during this investigation. In addition, Dr. Robert S. Schwab, Director of the Parkinsonism Clinic at Massachusetts General Hospital, has accepted my invitation to evaluate personally the follow-up results in the same series of cases. It is my hope that these studies will not only provide an objective evaluation of the results which have been obtained in my own series of cases, but will also serve as a basis for the type of evaluation which is necessary for similar investigations in this field.

Summary

It has been the intention of this presentation to describe the past efforts of neurosurgeons to alleviate the symptoms of parkinsonism and to summarize the status of current efforts. It has also been my purpose to demonstrate by cinematographic records and the presentation of one of our cases in person, the type of result which can be obtained in far advanced cases of parkinsonism by certain neurosurgical techniques. There is still much more unknown about parkinsonism and its therapy than is known at the present time. However, there are certain conclusions which can now be substantiated by fact. These conclusions are:

1. The most profitable approach to the neurosurgery of parkinsonism at the present time is surgery of the basal ganglia, particularly the globus pallidus. Two original techniques which have been used in a series of 145 cases have been described and some of the results presented tonight. As I have indicated, others in this country and abroad have been developing surgical techniques aimed at the basal ganglia and have reported promising and hopeful results.

2. Tremor and rigidity of parkinsonism can be relieved neurosurgically without sacrificing motor power. In my own experience such relief has been demonstrated to persist for as long as three years without any recurrence of symptoms up to the present time. In some cases other stigmata of the disease have been alleviated as well. Not all cases are suitable subjects for surgical intervention. Of those operated upon in our series of cases 70 per cent have received lasting alleviation of tremor and rigidity.

3. In addition to the perfection of surgical techniques, particular attention should be paid to the selection of patients as possible candidates for neurosurgical therapy and to the development of a more useful

classification of patients with the parkinsonian symptom complex.

4. There is a factual basis for judicious optimism regarding the future contributions of neurosurgical therapy to the welfare of patients with parkinsonism. In order for these potentialities to be realized, patients must be cautiously and judiciously selected as candidates for operation and operations of documented merit must be painstakingly performed.

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