

PARAPLEGIA FOLLOWING WAR*

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1. INTRODUCTION

TWICE in three decades, war with its thousands of casualties has created a large number of patients with serious disturbance, or total destruction, of spinal cord function. During and following World War I admirable studies were achieved in spinal reflex activity. The work of Head and Riddoch¹ is an example. In the intervening years, work done by the neurologist, neurosurgeon, physiologist, and urologist, has laid the foundation for a new approach to the problems of the paraplegic patient. Emphasis has shifted from the field of neurophysiological research to the many aspects of therapy, some of them experimental still, designed to return the paraplegic patient to independence. The work to be presented has developed from that of Munro^{4, 7} and Deaver and Brown.²

During the summer of 1945 some 200 paraplegic patients were gathered into four centres strategically placed across Canada. During the period from February 3, 1945 to June 1, 1946, 103 post-traumatic paraplegic patients from the Armed Forces have been treated in Christie St. Hospital and Lyndhurst Lodge, Toronto.

The paraplegic during the days following his injury is numbed by what has happened to him. One moment he is a healthy, keen, strictly disciplined young man. The next he is gone from the waist down, paralyzed, insensitive, unable to fulfil the basic requirements of life in terms of emptying his bladder and bowels. He is fully dependent upon those around him. It is a shattering experience, as anyone who has received the confidence of these men knows well. Eventually he arrives in Canada. The journey has been an exhausting one by hospital ship and hospital train. A multitude of problems beset such a patient. Pressure sores commonly developed during the period of evacuation. Practically

every patient arriving in Canada had a pressure sore over the sacrum and often over both trochanters as well. Suprapubic cystotomy had been done on all patients with serious spinal cord injury. Sexual function is abolished and many men are fearful of meeting their fiancées or wives. This combination of circumstances produces a feeling of lassitude, inertia and despondency.

That one may appreciate this problem, it is necessary to picture a ward full of patients some months after they have been injured. Should circumstances prevent the establishment of suitable wards, staffed with keen and understanding orderlies, nurses and doctors, such patients quickly develop the feeling that they are forgotten men. A state of despondency develops, spreading from one to another, including the relatives, the visitors and ultimately the professional staff who serve the patients. One of our colleagues was reminded of the moving pictures of a German concentration camp—feverish, listless, undernourished, hopeless patients; spontaneous activities reduced to a minimum, the patients doing little or nothing for themselves, believing that they should not or could not. Chills and fever as a consequence of genitourinary sepsis are taken for granted. Pressure sores do not heal. The patients are toxic, nutrition is poor, blood proteins are decreased. The whole is a vicious circle.

2. APPROACH TO THE PROBLEMS OF PARAPLEGIA

To start planning the treatment of a large number of paraplegic patients is to be non-plussed by the variety of problems requiring solution. To know where to begin is difficult. Quickly the realization develops that a team effort must be evolved.

Survival of these men depends upon the urologist preventing or controlling genitourinary sepsis. Though his technical effort be of the highest order, he is doomed to failure unless the patients can be made sufficiently mobile that gravity aids in draining the kidney pelvis and ureters. The patients must be convinced that independent mobility is desirable. This can only be brought about if orderlies, nurses, doctors and physiotherapists know that the majority of paraplegic patients can master wheel-chair life and many can learn independent brace-walking with crutches. Unless the patients can control the paralyzed bladder and bowel sufficiently to ensure that they may

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safely go beyond the confines of the hospital wards, independent mobility has but little to offer. The campaign necessary to achieve successful retraining and rehabilitation of paraplegic patients is total war. Success is at the mercy of every member of the team from the nursing orderly to the surgical specialist.

This presentation outlines the treatment of paraplegic patients by physician, neurosurgeon, urologist, plastic surgeon, physiotherapist, nurse and orderly. Particularly must it be emphasized that one doctor is required who appreciates the total problem and who will integrate all therapy. He is the key man. Though all aspects of treatment are interlocking, it becomes necessary to consider various aspects separately.

Table I outlines the distribution and completeness of the lesions of the spinal cord and cauda

TABLE I.
SPINAL CORD INJURIES

	Flaccid	Level	Spastic	Level	Total
Complete..	24	13 Thoracic	25	6 Cervical	49
		11 Lumbar		19 Thoracic	
Incomplete	29	6 Thoracic	25	12 Cervical	54
		22 Lumbar		12 Thoracic	
		1 Sacral		1 Lumbar	
				Total..	103

equina in the group of patients returned from overseas to Christie St. Hospital, Toronto. The relatively high incidence of incomplete lesions should be noted; these are particularly common in the lumbar and sacral regions. In the thoracic and cervical regions, incomplete lesions commonly result from a missile passing through a transverse or spinous process. Actually the projectile need not fracture the spine, for spinal cord injury may result from the waves of force radiating from the path of a high velocity bullet or shell fragment.

The segmental level often bears but an approximate relation to the level of wounding for again the radial contusion or field of force produced by a missile may cause destruction of the cord several segments above and below the level of injury. This was well described by Holmes³ in his Goulstonian Lectures of 1915. It has been confirmed by our post-mortem and clinical studies.

3. THE GENITO-URINARY TRACT IN PARAPLEGIA

The Royal Canadian Army Medical Corps Overseas decided, in 1942, that under the circumstances of war, suprapubic drainage of the paralyzed bladder was a lifesaving measure. This was achieved by means of a tube introduced high in the anterior abdominal wall and high in the bladder. This decision was reached with full knowledge of the great merit of tidal drainage *efficiently* carried out. Knowledge was also acquired regarding the difficulty of attempting tidal drainage during the many and varied phases of evacuation from Europe to Canada. *In Canada, where the paraplegic patient can and should be rapidly evacuated to a centre prepared and equipped to deal with the paralyzed patient, tidal drainage remains the treatment of choice.*

(a) *Introduction.*—Immediately following a severe spinal cord injury a flaccid paralysis of the legs is accompanied by a flaccid paralysis of the bladder. This may persist for weeks or months. With recovery from spinal shock, if the injury to the spinal cord is above the first sacral segment, reflex activity of the bladder may develop concurrently with reflex activity of the legs. Stretching of the bladder wall is the activating stimulus. Reflex contractions of the bladder are at first incomplete and result in expelling but a few cubic centimetres of urine, leaving a large residual urine. In the absence of serious infection it is possible for reflex activity to increase until it empties the bladder or leaves but 30 to 60 cubic centimetres of residual urine. This is commonly described as the "automatic" bladder. With a large fluid intake (3,000 to 4,000 cubic centimetres in twenty-four hours) a residual urine of 30 to 60 cubic centimetres need not give rise to trouble.

Where the lesion in the spinal cord is at or below the 1st sacral segment, destroying the 2nd, 3rd and 4th sacral segments, or the cauda equina, or the nervi erigentes connecting the bladder with the cauda equina, there occurs a flaccid paralysis. Contractions of the bladder dependent upon the integrity of the spinal reflex arc cannot develop. Ineffectual contractions of the bladder detrusor mechanism do occur, presumably as a result of the properties of smooth muscle and the activity of nerve plexuses in the bladder wall. This is the "autonomous" bladder.⁴

The preceding brief account of the disturbance of bladder function resulting from spinal cord injury indicated that emptying of the bladder *per urethram* should be possible in the majority of cases. Catheters should not be necessary.

These considerations justified the following objectives: (1) That neither urethral nor suprapubic catheters should be used. (2) That reflex micturition, initiated by the patient, should be achieved where the bladder connections with the spinal cord had not been destroyed. (3) That in the autonomous bladder, micturition should be achieved by straining while sitting on the toilet seat. (4) That patients would wear rubber urinals as a precaution against incontinence.

(b) *Treatment of the paralyzed bladder.*—Some 77 patients with suprapubic drainage were suffering from severe mixed infection of the bladder. *B. proteus* was the predominant organism. In every case the urine was strongly alkaline. Renal and vesical calculi were common in this group. In certain instances the suprapubic tube did not prevent intermittent excretion of urine *per urethram*. This occurred on the one hand with an autonomous bladder during physical stress, and on the other hand with an automatic bladder during periods of increased reflex activity. Most patients eventually came to regard the presence of a suprapubic tube with marked distaste.

The steps which have led to the elimination of the suprapubic tube and urethral catheter may be outlined as follows: (1) Tidal drainage with ½ strength “M” solution⁵ was successfully managed through a suprapubic tube in the majority of cases. This helped greatly to reduce cystitis and stone formation. (2) Removal of the suprapubic tube was undertaken using intramuscular penicillin and streptomycin in large doses, when the tube could be clamped and urine passed *per urethram*. (3) Suprapubic closure was carried out surgically when the fistula did not heal spontaneously within a reasonable period. (4) Tidal drainage *per urethram* was used following suprapubic closure to increase bladder capacity or when residual urine was excessive. (5) Bladder calculi which did not dissolve in “M” solution were removed. (6) Transurethral resection of the vesical neck⁶ is used where retention follows removal of the suprapubic tubes.

The treatment of the paralyzed bladder in these 103 patients, while overseas, consisted of suprapubic cystotomies in 77, urethral drainage in 17, and 9 had but transient retention requiring catheterization on a few occasions. Of the 77 cystotomies, 61 have been closed, 24 by operation and 37 healed following institution of urethral drainage by a retention urethral catheter.

(c) *Streptomycin.*—Streptomycin was particularly useful in the earlier cases where *B. proteus* infection was well established and the urine highly alkaline. Massive doses of penicillin and streptomycin rendered the urine sterile in a few hours, save for the incidence of an organism resembling *B. coli* which the Department of Bacteriology of the Toronto General Hospital was unable to identify. *Pseudomonas pyocyanea* also persisted in some cases but did not seem to exert any particularly harmful effects. Within two to three days the urine became acid. The administration of penicillin and streptomycin was continued until the suprapubic wound was healed and the urethral catheter removed. There is no doubt that in this group of patients in whom infection with Gram-negative urea splitting organisms was rife, streptomycin was of substantial value. Of recent months, when a more concerted attack has been possible upon the urological problems of patients shortly after admission, and infection has not been such a feature, suprapubic cystotomies have been successfully closed without benefit of streptomycin.

In assessing patients, the results of treatment of the paralyzed bladder are defined as satisfactory when there is: (1) Freedom from clinical evidence of sepsis (*i.e.*, chills, fever, etc.) and from radiological evidence of stone formation and pyelonephritis. (2) Excretion of urine without dissemination of urine or of a uriferous odour. (3) Elimination of suprapubic tube and urethral catheter.

TABLE II.
 FUNCTION OF BLADDER

Cord injury	FUNCTION OF BLADDER		
	Voluntary	Automatic	Autonomous
Incomplete.....	24	7	12
Complete.....		17	8
	Retention		Suprapubic
Incomplete.....	5	6	
Complete.....	13	11	

Table II shows that of 96 surviving patients, there are at present 68 with satisfactory bladder function and 24 in whom a form of "voluntary" micturition is possible. This means that the patient is able to initiate micturition voluntarily and have sufficient control that with reasonable precautions, he can avoid incontinence. Twenty-four patients have developed satisfactory spinal reflex micturition, the "automatic bladder". They are capable of initiating reflex micturition by an appropriate stimulus. Twenty patients have an autonomous bladder, *i.e.*, emptying of the bladder is achieved by straining or manual pressure. In both groups, "automatic" and autonomous, the residual urine is sufficiently low, though variable, that by means of a large fluid intake, sepsis is not a troublesome feature.

Retention of urine is present in 18 patients, following removal of the suprapubic tube necessitating the use of urethral catheter and tidal drainage. At present this group is being attacked by means of transurethral resection of the neck of the bladder, as described by Emmett.⁶ It is too early to speak of results, though they are encouraging. Other patients with excessive residual urine pass a catheter at night and employ tidal drainage. Table II indicates 17 patients with suprapubic tubes; six of these patients died while still undergoing suprapubic drainage of the bladder. All patients with "automatic" or autonomous bladders, and many with "voluntary" micturition or suprapubic tubes wear urinals because of stress incontinence.

(d) *Complications.*—Twenty-nine patients had on admission or have since developed calculi, 20 vesical, 15 renal and 6 with both renal and vesical calculi. Renal infection without nephrolithiasis has been proved in 11 patients either by means of cystoscopy and retrograde pyelograms or intravenous pyelograms. Bladder infection is considered to have occurred in every patient who had either an indwelling urethral or suprapubic catheter. The complications recorded are the total number which have been observed since the intensive study of these patients developed in February, 1945. At present there are but 4 patients on the neuro-surgical service with either renal, ureteral or vesical calculi.

At the present time only 3 patients from the group who have useful bladder function suffer from serious demonstrable renal complications.

One, a man of over 50, has a small renal stone. Another has a large kidney which functions very poorly and will likely require to be removed, and from the third repeated cultures of the left kidney urine grew *Lactus xerogenes*. Others of this group may have infected kidneys but there is no clinical or radiological evidence to establish the diagnosis. From the group with unsatisfactory bladder function 3 have calculi, 2 are renal and 1 ureteral.

All patients should have an intravenous pyelogram every three months during the year following injury and at appropriate intervals thereafter. The rapidity with which stones form is sometimes extraordinary, even when patients have progressed to wheel-chair life, or the use of braces and crutches. However, it is a much more rare occurrence once the patient is mobilized than when he is recumbent in bed.

Prostato-epididymitis has developed in 10 patients. Commonly it occurs while tidal drainage through a urethral catheter is in progress. Epididymitis has developed in patients with suprapubic drainage and following a single catheterization. In 3 patients an abscess has formed and drained through the scrotum. One orchidectomy has been necessary.

(e) *Mortality.*—There have been 7 deaths during the period under consideration, February 3, 1945, to June 1, 1946. In two instances, death was attributed directly to sepsis of the genito-urinary tract. Intraperitoneal rupture of a perinephric abscess occurred in one of these two cases; in the other case one kidney was destroyed at the time of injury and the development of nephrolithiasis and pyelonephritis in the remaining kidney resulted in uræmia. Extensive pressure sores produced extreme inanition in two cases and additionally, there was sepsis of the genito-urinary tract in the form of cystitis in one patient and pyelonephritis in the other. Death was considered to be due primarily to disturbances of nutrition with genito-urinary sepsis as a contributory factor. In two patients death resulted from disease which could not be attributed to spinal cord injury, *i.e.*, acute liver necrosis in one and coronary thrombosis in a second. One patient who had achieved a satisfactory wheel-chair life in spite of an almost complete lesion at the 7th cervical segment, was killed in a motor-car accident at a railway crossing.

The long term prospects of survival cannot be predicted at this time. It is our belief that

half or more of these patients will live for years as a result of intensive urological supervision, physical activity and the use of penicillin and streptomycin in the control of acute exacerbations of cystitis and pyelonephritis.

4. CONTROL OF THE PARALYZED BOWEL

Closely related to the problem of the paralyzed bladder is that of paralysis of bowel function. While it is not a threat to life, paralysis of the bowel is one of the great obstacles preventing restoration of patients to society. No patient will mingle with his fellow men outside of hospital if he is uncertain as to bowel control.

While still in bed, enemata administered every two days usually control elimination from the bowel. Sometimes pituitrin or prostigmine given intramuscularly at the time of the enema aids evacuation. When the patient is able to leave his bed the enema is administered on the toilet, first by the orderly and at a later stage by the patient. Many men progress so that they are able to empty the bowel daily with only occasional recourse to enema. Some initiate evacuation digitally or by using rectal suppositories, in combination with carefully regulated use of laxatives such as petrolagar, agarol, liquid paraffin, milk of magnesia and cascara. Patients are made responsible for the choice and administration of laxatives best suited to their individual needs. Physical exercise invariably improves bowel function. Efficient self-care is impossible until the patient is able to get himself to the toilet.

5. SEXUAL FUNCTION

Early, complete and honest explanation of the import of this loss of function to both the patient and to his wife commonly leads to acceptance of the handicap. So far there have been relatively few men who have been forsaken by their wives for this cause. In fact three or four men have married women who were fully conversant with the patient's impotence.

6. ANTERIOR RHIZOTOMY

Munro⁷ in a lecture before a clinical group in Toronto in January, 1945, outlined the results he had achieved in abolishing mass flexion reflexes by dividing the anterior roots from the 10th thoracic, through and including the

1st sacral root, bilaterally. This abolishes or breaks the reflex arc and converts a spastic paralysis to a flaccid paralysis. Munro first attempted this operation in 1933 and has since carried out the procedure on ten patients.

In 9 of this group of 103 patients with spinal cord injury, severe flexor spasms of the legs have prevented the patient from being made comfortable in bed and have retarded the healing of bedsores. Adequate care of the genito-urinary tract became difficult or impossible and life in a wheel-chair or walking with braces could not be attempted.

For a varying period, usually three or four weeks following transection of the spinal cord, flaccid paralysis of the lower extremities is present. This is the period of spinal shock. The first sign of reflex activity to appear is dorsiflexion of the great toe; the sign of Babinski. Gradually the response to plantar stimulation spreads to include the flexor muscles of the knees, the flexor muscles of the hips, the adductors of the hips and finally the muscles of the anterior abdominal wall. Paroxysmal sweating may develop. Evacuation of the bladder commonly accompanies the spasm; less commonly the bowel contents may be expelled. This state was described by Head and Riddoch¹ as the "mass reflex" and when fully developed, it may be initiated by as gentle a stimulus as blowing on the patient's skin or jarring his bed. With the passage of time, shortening of the flexor muscles of the lower limbs results and the knees come to be drawn up against the patient's chest. This posture necessitates that he be nursed on one or the other side. The emptying of the bladder and excessive sweating render it difficult to keep the bed dry. Inevitably trochanteric pressure sores develop. Accompanying the spasm of the abdominal muscles is abdominal discomfort. The patient's rest and sleep are disturbed and his appetite fails. Genito-urinary sepsis progresses and the end result is death.

The outstanding problem in anterior rhizotomy as described by Munro, is the accurate identification and interruption, bilaterally, of the anterior roots forming the reflex arc—T.10-S.1 inclusive. Preservation of the 2nd, 3rd, and 4th sacral roots is necessary or a flaccid paralysis of the bladder will inevitably result. In fact, it is our present conviction that the 1st sacral root should also be spared bilaterally.⁸ Munro⁷ considered that the anatomical key to the problem was the relationship of the 1st lumbar root to the last slip of the denticulate ligament. Following Frazier and Allen⁹ he considered the intraspinal roots that enclose the last slip of the denticulate ligament and form the nerve leaving by the

dural opening next below to be the 1st lumbar. Anatomical and surgical studies by MacDonald, McKenzie and Botterell⁸ indicate that the last slip of the denticulate ligament is variable in level and that it has not a constant relation to the 1st lumbar root. In a series of 10 dissections, the root identified by this method varied from the 12th thoracic root on one side to the 2nd lumbar root on the other side. An alternative method of identifying the roots to be divided consists of recognizing that the lowest large anterior root is the 1st sacral root. By careful identification of the 10th thoracic vertebra preoperatively the anterior roots from T.10 to L.5 inclusive can be divided, with a reasonable degree of assurance. Undoubtedly it is more difficult to identify the 1st sacral root at operation than in the cadaver.

In this group of 9 cases in whom the mass reflex was disabling, anterior rhizotomy has been performed on 5. No postoperative deaths occurred and all have improved substantially. Weight gains have been recorded, bed sores healed or were closed surgically and the patients are making progress with retraining. Of the 4 who did not have a rhizotomy 2 died shortly after coming to this service. Undoubtedly the fully developed mass reflex contributed greatly to the development of pressure sores and genito-urinary sepsis which produced death. Two are now awaiting operation.

The preservation of an "automatic" bladder following rhizotomy has been a problem. In one instance, reflex activity of the bladder was not disturbed. A flaccid paralysis of the bladder requiring a urethral catheter and tidal drainage followed operation in 2 cases. One of these followed an operation in which the last slip of the denticulate ligament was used as the anatomical landmark. No reflex activity of the bladder could be demonstrated before or after operation in one case. In another case, cutaneous ureterostomies have prevented assessment of bladder function.

Our opinion is that abolition of reflex activity of the bladder results from two causes. (1) Miscounting and misjudging the roots which have been divided. (2) Interference with the blood supply to the lower end of the cord by division of the arteries accompanying the anterior roots. It is often difficult to separate the root from the artery and insufficient emphasis has been placed on the need of preserving these blood vessels. The 1st sacral roots were spared bilaterally in the patient who had a flaccid bladder before operation. This has persisted, though the presence of slight reflex activity in calf muscles and hamstrings gives grounds for hope.

7. PLASTIC CLOSURE OF PRESSURE SORES

Pressure sores can be prevented by turning the patient every two hours day and night; by changing a wet bed at once and by using inner spring mattresses and flannelette draw-sheets. Having developed large infected pressure sores much serum protein is lost and healing potentialities are diminished. Frequently only surgical closure of the sore will be effectual. The Plastic Surgical Division has greatly shortened the time necessary to close pressure sores. By means of a rotation flap technique,¹⁰ large deep pressure sores with fibrosed margins and base have been successfully closed. Large, papery scars adherent to the sacrum break down repeatedly month after month and the transference of healthy skin shortens the delay before retraining and rehabilitation can commence. A scar adherent to an ischial tuberosity may break down repeatedly when subjected to pressure by the sitting position. Some 20 patients have had pressure sores closed by rotation flaps. Discounting the loss of a small amount of tissue along the suture lines, sacral, trochanteric and ischial pressure sores have been successfully closed with full thickness skin in 16 out of 20 patients. The presence of flexor spasms of the legs prevents successful closure of trochanteric pressure sores.

8. NUTRITION

Malnutrition commonly occurs in paraplegic patients as a result of the complications arising from the paralysis. These complications are: chronic or acute infection of the genito-urinary tract; the development of pressure sores which become infected and serve as an avenue for the loss of serum protein; pain and mental depression. Each may produce anorexia resulting in decreased intake of food while infection depletes the body protein reserve.

Treatment consists of removing the causes of protein depletion, which are genito-urinary sepsis and direct loss through ulcerated surfaces of infected pressure sores, and of assuring adequate protein intake by relieving pain when possible and improving morale and creating the desire to eat. Diets with high protein and vitamin content are served in an appetizing manner. Such diets must be supplemented in some cases by drinks containing protein concentrates. In a few instances where the serum proteins are very low, transfusions of whole blood and plasma may

be necessary. A co-ordinated attack on all these complications gradually brings about an improved state of nutrition.

9. PAIN IN PARAPLEGIA

Gowers¹¹ in the last century described certain abnormal sensations suffered by paraplegic patients; "a sense of constriction of a limb, a band around the trunk, a feeling of great heaviness of a limb". He also recorded root pain related to the level of the injury to the spinal cord and nerve root. Twelve patients in this group of 103 endured pain of sufficient severity to prevent or delay vocational training, physical retraining, the enjoyment of recreation and uninterrupted sleep. The gaunt, thin appearance characteristic of this group of men singles them out readily among a group of paraplegic patients.

Patients describe pain as burning, stabbing or crampy and commonly it occurs in spasms. The pain is projected to those regions where perception of sensation is lost or disturbed as a result of injury to spinal cord and cauda equina. Eleven of the 12 patients with disabling pain had lesions involving cauda equina. The pain may be referred to the lower extremities, external genitalia, perineum or back. Rectal dysaesthesiae are of special interest, for they occurred in 5 patients. The sensation was described by 2 as painful, resembling "a spade in the rectum"; this resulted from a complete lesion of the lumbar cord and cauda equina in one case, and a partial lesion of the cauda equina in the other. Three patients with severe though incomplete lesions of the cauda equina complained of burning pain in the rectum, aggravated by enemata or the presence of scybalous faeces.

The 12th patient suffered severe girdle root pain secondary to destruction of several segments of the upper thoracic cord and roots.

Relief of pain for these patients was sought first through improvement in general health; the program of physical retraining leading to independent mobility was put forward. Every effort was made to deal with genito-urinary sepsis, pressure sores, and under-nutrition as expeditiously as possible. Improvement in general health and a planned campaign of retraining leading to independence produced a greatly improved emotional state. Patients felt less acutely that they were "forgotten men". With the improved physical, mental and emotional state, perception of pain was

decreased. Five of the 12 patients have gone on to complete retraining and rehabilitation, in spite of pain; 3 of these 5 were drug addicts at one stage.

Bilateral pain tract section (4 cases) and resection of scar tissue replacing the cord and involving roots (1 case) comprised the surgical treatment of central pain to date. The 4 patients treated by pain tract section had lesions involving cauda equina; 2 had mastered brace walking and could look after themselves completely, but could not carry on and work or sleep uninterruptedly; 2 patients could not achieve wheel-chair life because of pain and were difficult to look after in bed. "A red hot spade in the rectum" was the worst feature in one case and sitting so aggravated this sensation that he could not get up.

All 4 patients who have had bilateral pain tract section have obtained substantial relief. In these patients, sleep has been greatly improved and physical retraining of the 2 bed patients has progressed. Each man is well pleased and grateful for the relief which has resulted. There follows a brief report of a patient on whom a bilateral section of the pain tracts was done.

CASE 1

Lieut. W.O'C., aged 24. This patient was wounded by a shell fragment on July 16, 1944. The missile entered the right lower chest, traversed the spine fracturing the 3rd and 4th lumbar vertebrae. The cauda equina was injured with immediate onset of paraplegia. At once he was conscious of severe burning pain in the legs, the external genitalia, the perineum and the low back. Pain in the rectum was a prominent feature. Pain persisted unabated in the legs, rectum, perineum and external genitalia. Genito-urinary sepsis and right nephrolithiasis developed and a perinephric abscess formed. Drug addiction developed when opiates were administered postoperatively and during evacuation to Canada. Pain in the rectum, aggravated by enemata, perineal pain and pain in the external genitalia aggravated by irrigation of the bladder and burning throughout the legs proved more than could be endured. Extreme hyperaesthesia of the genitalia, legs and perineum made washing these parts intolerable. The patient was rapidly losing weight and was obviously going to die when a bilateral pain tract section was performed in the autumn of 1945. The relief of pain was extraordinary, for the man was immediately able to wash the affected parts, to permit tidal irrigation of the bladder, to receive satisfactory enemata and to undertake the retraining program.

Surgical treatment of root pain associated with spinal cord injury in the thoracic region has been necessary in but one instance. A brief summary of that case follows:

CASE 2

V.B., No. A.47594, aged 33. This man received a bullet wound which traversed the spinal canal through the 4th, 5th and 6th thoracic vertebrae. With the pas-

sage of time a mass reflex developed and bilateral trochanteric and sacral pressure sores became large, deep and infected. Genito-urinary sepsis was severe. In addition, there was girdle pain at the level of the 4th to 7th thoracic segments with hyperæsthesia over this distribution. An anterior rhizotomy, T.10 to L.5 inclusive rendered the spastic legs flaccid save for slight activity in calf muscles and hamstrings. The girdle pain then became very prominent in the man's consciousness and no progress could be made. The cord was found at operation to be replaced by scar tissue through at least 2 segments, the scar tissue in its upper part involving at least one pair and possibly a second pair of normal anterior and posterior spinal roots. The cord was transected immediately above the level of the lesion, the scar tissue replacing the cord and the spinal roots caught up in scar tissue were resected.

Relief of pain has been substantial, although the patient is still complaining of hyperæsthesia of a lesser degree of severity than prior to operation.

Bilateral pain tract section has proved of substantial value in the treatment of this small group of patients. All cases who have come to operation have been relieved of pain to such an extent that they have been able to carry on satisfactorily. To date, no yardstick has been evolved whereby any forecast can be made as to the results following section of pain tracts. Similarly, it has not been possible to foretell in which patients pain will decrease in significance, as general health improves and activities increase in range, so that a satisfactory life is possible without surgical intervention.

Unilateral and bilateral lumbar sympathetic blocks have been tried without success in a single case.

Two patients must be regarded as failures. Pain prevented one man with an incomplete lesion of cauda equina from increasing activity. He died of coronary thrombosis. In retrospect, he would probably have benefited from bilateral pain tract section. A second patient with considerable power and sensation in the legs is nonetheless making poor progress because of pain. He is hysterical and unstable but will likely require pain tract section.

10. RETRAINING

Dressing and undressing, a bath and a multitude of other daily activities seldom considered in the life of a normal individual are tasks of some magnitude for the paraplegic; additionally there are the problems of the paralyzed bladder and bowel as outlined above. To restore a paraplegic patient to a useful place in society, it is necessary that he learn to deal with his paralyzed bladder and bowel, master wheel-chair life, and if possible learn to stand and walk with braces and crutches. Unless self-care is mastered, the patient is dependent

on others for his every need, and such dependency destroys initiative.

The retraining program is designed to teach self-care, to restore physical strength and vigour to the non-paralyzed portion of the body, to solve psychological and emotional problems and to provide independent mobility by wheel-chair and walking with braces and crutches. The patient can then meet the social and economic challenge of life. To be effectual, physical training must be purposeful. The muscles that are strengthened are to be used in self-care and locomotion. Self-sufficiency must be presented as more desirable than dependency upon others. Return to social and economic activities is held up as a goal which will provide a happy and satisfying life.

The schedule of retraining begins with the bed patient and ideally continues until he is able to walk, is living at home, and is at work. The gravity of the disability, mental incapacity or lack of determination may arrest progress short of this ideal. The central part of the program consists of physical training. Improved general health and well-being usually solve the problems of emotional adjustment to the difficult circumstances surrounding paraplegic patients. Some learn to care for all their personal needs before they learn to walk and some are not entirely self-sufficient when they walk with braces. Vocational training is introduced at varying stages, depending on the type of vocation selected, the availability of retraining facilities and the ease with which the individual patient is able to cope with his retraining.

For purposes of discussion, the retraining program is divided into five parts, though in practice there is a good deal of overlapping in the various stages: (1) bed; (2) wheel-chair; (3) gymnastic training and preparation for brace-walking; (4) parallel bar walking and exercising; (5) crutch-walking with braces.

Retraining commences while the patient is still in bed and gradually progresses. Passive movement and massage of paralyzed extremities lead to active participation in tension exercises. The use of chest-expanders and bar-bells is introduced. Concurrently, the patient is encouraged to care for himself; soon with instruction, he is able to wash and feed himself, to change his pyjama jacket and trousers, and by grasping the bed-frame exerciser (Fig. 1) to turn himself. The patient is now made responsible for the care of his back. He must turn independently at

two hourly intervals by day and by night. Some men become habituated to awaken regularly, others must set an alarm clock.

Special exercises designed to develop the crutch-walking muscles are introduced. These are the muscles of the pectoral girdle and arms used to raise the body when in the sitting position. It is a major accomplishment for such a patient to sit up at first, for he becomes faint

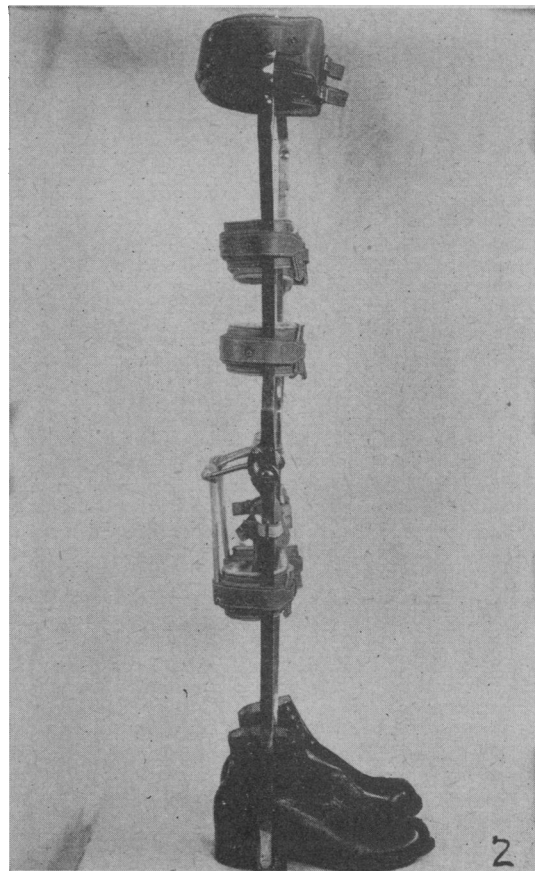


and is very unsteady. Learning to sit erect, unsupported, is followed by sliding the legs over the edge of the bed and carrying out arm exercises, thereby improving muscular activity and acquiring a sense of balance. Failure to walk may be attributed more often to a lack of balance than to a lack of physical strength. When the patient is able to dress himself each day the danger of the joints becoming stiff no longer exists, for putting on his trousers provides a complete range of passive movement of the legs.

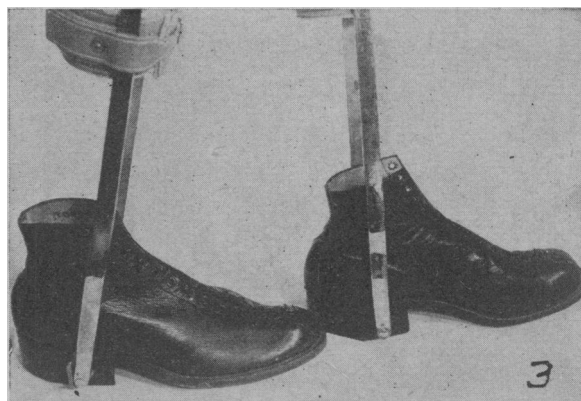
The next major step is unaided transfer from bed to wheel-chair. This leads to independent life in a wheel-chair. The patient's activities are now limited only by stairs and curbs. Complete mastery of wheel-chair life implies that the patient can go to the bathroom, transfer from the wheel-chair to the toilet, administer his own enema, evacuate his bladder and get in and out of the bathtub. Care must be taken to avoid burns from excessively hot water. In addition, he will learn to get from wheel-chair to and from an automobile without assistance.

The Everest and Jennings Universal Model Wheel-Chair is the most satisfactory type yet developed. It combines light weight (44 lbs.) with durability. The collapsible feature permits the chair to be placed in

the rear seat or trunk of a car. The removable arms enable paraplegic patients to transfer from wheel-chair to bed, toilet or motor car and back. The mechanical excellence of construction makes wheeling effortless and reduces repair work to a minimum.



Some men elect to remain at the wheel-chair level of activity. Patients who are determined to achieve complete independence must master brace-walking with crutches in addition to wheel-chair life. This requires further strenuous exercises which are carried out initially in the wheel-chair; wall pulley-weights, the punching bag and medicine ball are used to advantage. There is also a period of strenuous retraining on the



mats in the gymnasium. The patient must learn to transfer himself from wheel-chair to mats and back without assistance. Exercises of the trunk and arms are carried out and walking on the buttocks with short crutches is used to develop balance as well as strength.

Bilateral long leg braces (Fig. 2) with a knee lock and ankle stop are supplied. The braces are united by a pelvic band having a joint at the hip with a stop which prevents hyperextension. They can be put on by the patient, unassisted, in five minutes. The braces weight 9 pounds, 8 ounces and are made of special chrome molybdenum steel. They are not designed to support the body weight but by splinting the legs in full extension or hyperextension at the knee permit the skeleton to support the patient. Special boots (Fig. 3) of a hockey-cut type with a steel arch support are made to measure for each patient. A pair weighs 2 pounds, 12 ounces. The hockey-cut design permits a patient to place his insensitive feet in the boot properly. When this is not done the toes sometimes become flexed and pressure sores develop. The flexibility of the boot and the good fit minimize friction on the heels. With these boots pressure sores have not developed, as has been the case where ordinary shoes were supplied.

Wearing the braces the patient stands between the parallel bars. He is taught the various gaits he will ultimately use.¹² Should the lesion be low and some power of flexing the thighs be present, the four-point crutch-walking gait can be mastered readily. If the legs are totally paralyzed the tripod or swing-through gait is to be preferred. Following a period of walking between parallel bars the patient becomes ready for crutch-walking. The most suitable crutch is that which has adjustable hand-grips and tips.

When the patient is satisfied regarding the overall length and the height of the hand-grip, non-adjustable crutches are provided according to these dimensions. The first few steps taken from the parallel bars consist of shuffling the feet forward but not as far as the crutches. The crutches are then lifted and placed forward, the shuffling movement being repeated. The shuffle is gradually lengthened until the feet swing through between the crutches. Throughout this phase an attendant follows behind to prevent the patient falling backwards. The fatigue resulting from the early effort to walk with braces is only in small part physical, for the emotional strain of standing erect when the balance is not well developed is extremely tiring. With constant practice, in one month the average patient will walk 100 yards or more, will learn to ascend and descend stairs provided with a railing, will go up and down ramps and curbs and sit down upon and rise from all types of chairs.

The despondency and depression resulting from such a disabling disaster as paraplegia, will be largely dispelled when a patient finds that he can care for himself and become mobile. Even fairly marked psychoneurotic or psychotic tendencies become less manifest.

11. REHABILITATION

The primary purpose of treatment at every stage from bed to brace-walking is, to return the patient to independent life beyond the confines of hospital or paraplegic colony. Many individuals less gravely disabled than paraplegics tend to remain in the shelter of institutions. Many times, financially adverse circumstances enforce hospitalization but this does not apply to paraplegics who are the responsibility of the Department of Veterans' Affairs.

During each stage of treatment, ways and means were found to encourage the paraplegic to leave the hospital, at first for only a few

hours. The bed patient was sent home for the week-end by stretcher and ambulance as soon as he had learned to look after his back and bladder. Patients invariably returned with their morale high and renewed determination to make progress.

Once the stage of wheel-chair life is attained, the patient is transferred from Christie Street Hospital to Lyndhurst Lodge, the half-way station between hospital life and home. At both Lyndhurst and Christie, wheel-chair patients are encouraged to go to hockey games, the races, concerts and restaurants. Even after paraplegic patients have learned to deal with the paralyzed bladder and bowel, many remain self-conscious and fearful of an accident. Only by overcoming fear and acquiring philosophical acceptance of occasional incontinence, will paraplegics learn to mingle once more in society. At Lyndhurst Lodge the main emphasis is on physical retraining and encouraging the paraplegic to use the resources of normal civilian life. There is no barber shop in Lyndhurst Lodge; patients are encouraged to use the stores of the neighboring community. Diversional occupational therapy is reduced to a minimum and the patients are sent to vocational training and rehabilitation schools regularly used by non-disabled veterans. A motor-car transports the men to and fro and at school a wheel-chair or brace-walking is used.

The assessment of intellectual capacity and a vocational interest inventory are essential if a patient is to be started in a new vocation compatible with his mental attainments and natural aptitude. Commonly paraplegics must be transferred from the field of manual labour to sedentary work of skilled or semi-skilled character. The rehabilitation officers of the Department of Veterans' Affairs work in close co-operation with patients and physician. A surprisingly large number of patients have shown energy and initiative by arranging independently to return to their former place of employment in some new capacity.

12. RESULTS

Accurate portrayal of the results of treatment and rehabilitation of paraplegic patients is impossible to show in tabular form. For example, incomplete lesions range from men with complete motor paralysis below the seventh cervical myotome, to men who have recovered completely save for precipitancy of micturition, impaired bowel control or slight motor or sensory deficit in the legs. In general, the incomplete paraplegic readily learns to deal with bladder and bowel and becomes ambulant and independent.

TABLE III.
REHABILITATION AND RETRAINING

Incomplete paralysis	96 patients	Complete paralysis
51	Total patients.	45
17	In hospital.	30
40	Self-sufficient, wheel-chair or better.	20
21*	Brace-walking.	18*
21	Walking—no braces.	0
34	At home.	15
30	At work or school.	9

*Two patients with incomplete lesions and four with complete lesions of the spinal cord find braces of no practical value.

Table III outlines the present status of 96 paraplegic patients, complete and incomplete, dealt with during the past 17 months. Thirty-seven of these patients had been in Christie Street Hospital or other military hospitals for periods up to 3 years, when the authors commenced work.

Of the 45 complete paraplegics, 6 have injuries of the cervical cord with involvement of the arms and hands. These 6 patients will require nursing care throughout their lives, though all but 2 are up and dressed daily and get about in a wheel-chair.

Of the remaining complete paraplegics who are in hospital, some have not completed their plastic, urological or neurosurgical treatment. Eighteen men are walking with braces and crutches, though it is likely that 4 will not make practical use of this method of getting about. The remaining 14 patients will find it very useful. The group who are at work or at school represent, for the most part, men who had a vocation which they are once more able to follow, or who were able to return to their former employers.

13. SUMMARY

1. The treatment of the paraplegic casualty with stable spinal column has been described, in relation to neurological surgery, urology, plastic surgery, physical retraining and rehabilitation in civilian life.

2. Chrome molybdenum long leg braces have been evolved and are put forward as being particularly suitable for paraplegic patients.

3. Custom made boots of modified hockey cut type, light in weight and particularly flexible are recommended as a means of preventing pressure sores of the feet.

4. A simple bed frame exerciser is described.

14. CONCLUSIONS

1. Paraplegic patients should be evacuated as early as possible to a centre fully equipped and specially staffed to deal with all aspects of treatment and retraining.

2. The treatment of paraplegic patients depends for its success upon the enthusiastic co-operation of the patient and all those attending him.

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RÉSUMÉ

Etude très complète du problème des paraplégiques de guerre, s'appliquant, incidemment à tous les paraplégiques, spontanés ou traumatiques, de la vie civile. Le maniement des paraplégiques est affaire de collaboration étroite, surtout entre le neurologue et l'urologue, et accessoirement, entre ceux-ci et le neurochirurgien, le radiologiste, le chirurgien spécialisé dans les plasties, le physiologiste et l'aide sociale. La part prépondérante des soins initiaux va à l'urologue qui jugera de l'opportunité de la taille vésicale, du cathétérisme, de l'irrigation continue, de la rhizotomie antérieure, selon le fonctionnement automatique ou autonome de la vessie ou selon l'abolition fonctionnelle de cet organe. La consultation continuera pour le traitement de la paralysie intestinale, pour l'annonce faite au malade de la perte de la fonction sexuelle, pour les opérations de chirurgie plastique, pour les soins à apporter aux malades atteints de troubles de la nutrition, pour le traitement de la douleur et pour les mesures d'entraînement à la vie normale et la réhabilitation au sein de la société. Il importe que le blessé ne se sente pas abandonné et il faut le convaincre dès le début qu'il peut devenir indépendant et prendre place son milieu. Un centre pour paraplégiques doit être pourvu de cette collaboration médicale totale indispensable et aucun aspect du traitement ne doit être négligé. Un médecin "dirigeant" doit coordonner le travail de chacun de ses collaborateurs.

JEAN SAUCIER

PRURITUS ANI*

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ITCHING about the anus although not a fatal or even a serious malady can become a disability sufficiently severe not only to prevent the sufferer doing his best work but even cause him to lose successive jobs and start him on the road to financial ruin. Although this latter eventuality is rare the former is very common, far commoner perhaps than most of us realize and sufficiently prevalent in the Army to constitute a definite problem and one which even the foremost proctologists have, up to now, failed to solve completely.

The purpose of this paper is to discuss the various causes and treatments of this condition and to present for your consideration a simple operation which may be used for the severe and intractable cases of idiopathic pruritus ani. This method has been completely success-

* Read at the Seventy-seventh Annual Meeting of the Canadian Medical Association, Section of Surgery, Banff, Alberta, June 14, 1946.