

A STUDY OF SPINAL FLUID PRESSURES IN OPERATIONS REQUIRING REMOVAL OF BOTH INTERNAL JUGULAR VEINS*

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THE OPINION is still held by many surgeons that operations requiring removal of both internal jugular veins are frequently associated with serious morbidity and an occasional fatality due to a sudden uncompensated increase in intracranial pressure. Since these conclusions were not supported by the experience of the Head and Neck Service of Memorial Hospital with a large series of second radical neck dissections, it was felt that a comparative study of the spinal fluid pressure during operation in patients subjected to first and second radical neck dissections might provide enlightening data on this subject. The results of such a study are presented in this report.

SOURCE OF MATERIAL

In an effort to obtain a complete picture of the variations in spinal fluid pressure under different circumstances, the patients in this series were divided into two main categories which were in turn broken down into several smaller groups. The first large subdivision consisted of those patients in whom one or both internal jugular veins were resected. Included in this general classification were (1) a group of 13 patients who had been subjected to a first neck dissection alone or in combination with a mandibulectomy or total laryngectomy; (2) a series of 13 second radical

neck dissections performed at varying intervals after the first side, and (3) nine simultaneous bilateral radical neck dissections associated with total laryngectomy or mandibulectomy. The technic of radical neck dissection used in all cases of the present series was described by Martin *et al.* in a recent monograph.⁴ In the second major category were grouped 17 control operative procedures which did not involve removal of an internal jugular vein. Although the operative field was confined to the head and neck region in a few of these patients, in the majority the surgery was of a more general nature.

The ages of the patients in the entire series ranged from 15 to 70 years, with the greater number in the middle decades. Since no effort was made to select good risk patients, many of the subjects were suffering from a variety of cardiovascular, renal, and metabolic disorders at the time of operation (See Table I).

TECHNIC

The premedication, consisting of morphine or Demerol and scopolamine in dosages comparable with age and physical state, was administered subcutaneously one and one-half hours before the scheduled time of operation. Upon arrival in the operating room, the patient was placed in the lateral recumbent position and a malleable Lemmon-Pilling continuous spinal needle inserted at L₃-L₄. After an initial

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reading of spinal fluid pressure had been obtained with the patient on the side, a shift was made to the supine position and the malleable needle connected by continuous spinal tubing to a spinal fluid manometer which was adjusted to the level of the patient's back.* This site was selected in preference to the level of the subarachnoid space in an effort to secure uniformity, since it is difficult to gauge the exact depth to which the needle has been inserted. In the supine position spinal fluid pressure readings were obtained with the head (1) in the midline and level with the body; (2) turned to the right and left side, and (3) hyperextended by means of two folded sheets placed beneath the upper thorax. The latter position is routinely employed during radical neck dissection to secure maximum surgical exposure.†

After these preliminary determinations were completed, anesthesia was induced with a 2.5 per cent solution of Sodium Pentothal and an oral or nasal intubation performed after relaxation had been secured by an intravenous dose of 80 to 100 units of dextro-Tubocurarine chloride. A combination of 2.5 per cent Pentothal and oxygen or nitrous-oxide-oxygen was employed for the maintenance of anesthesia during the operative procedure.

Spinal fluid pressure determinations were made after intubation and at frequent intervals throughout the operation, with special attention to the periods preceding and following division of the lower and upper end of the internal jugular vein. A final reading was obtained immediately prior to removal of the patient from the

operating table and in several cases lumbar puncture was performed once or twice during the first few days of the postoperative period.

In addition to the routine care given all head and neck cases, certain precautionary measures were adopted to prevent postoperative complications in patients in whom the second internal jugular vein had been removed. A tracheostomy was performed in all members of this group, and they were returned to the ward with the head of the bed elevated to facilitate venous return from the brain, but no effort was made to apply other than the usual pressure dressing.

RESULTS

Observations on Spinal Fluid Pressures.

A study of the spinal fluid pressures in Tables II, III, IV, V, and VI bears out the clinical impression that removal of the second internal jugular vein at a subsequent procedure or during the course of simultaneous bilateral radical neck dissections carries with it little danger of immediate severe morbidity or mortality. Although individual variations were present, the results were sufficiently consistent to justify the following general conclusions.

1. The initial spinal fluid pressure in the lateral recumbent position was frequently lower in patients scheduled for a first radical neck dissection or simultaneous bilateral radical neck dissections than in those who had been subjected to removal of one internal jugular vein at a previous procedure.

2. Patients of all groups showed a rise in spinal fluid pressure when shifted from the lateral to the supine position. This rise was somewhat greater in head and neck patients than in the control series involving operations on other parts of the body.

3. A marked elevation of spinal fluid pressure occurred in all patients on turn-

* The highest reading on the manometer was 600 mm. water. After that point the pressure is noted as 600 plus.

† Folded sheets were not used during head and neck operations which did not involve radical neck dissection or in operative procedures on other parts of the body.

ing the head far to the right or left in contrast to the minimal change produced by posterior extension.

4. In every patient subjected to a radical neck dissection there was an increase in spinal fluid pressure after division of the lower end of the internal jugular vein. The extent of this increase was usually no greater in the second neck dissections or in the second side of the simultaneous bilateral neck dissections.

was 350 mm. water on the first postoperative day in a patient on whom a second neck dissection had been performed several weeks after the first side.

Other Observations During the Operative and Postoperative Period. In addition to spinal fluid pressure determinations, all patients were carefully watched during the operative and postoperative period for unusual signs and symptoms suggestive of increased intracranial pressure. The result

TABLE I.—Pre-operative Complications in Patients with Spinal Fluid Pressure Readings.

Complications	Controls	Number of Patients		
		First Neck Dissections	Second Neck Dissections	Simultaneous Bilateral Neck Dissections
Cardiovascular, Renal				
Hypertensive cardiovascular disease.....	5	1	..	2
Hypertension.....	1	..	1	4
Previous myocardial infarction.....	1	..	..	1
Luetic aortitis.....	..	1	..	..
Pulmonary				
Asthma.....	..	1	..	..
Emphysema.....	..	..	1	1
Chronic bronchitis.....	..	..	..	1
Pulmonary fibrosis.....	..	..	..	1
Metabolic				
Diabetes mellitus.....	1	1	..	1
Generalized arteriosclerosis.....	..	..	1	..
Others				
Malnutrition.....	2	2	1	3
Alcoholism.....	1	..	..	5
Alcoholic neuritis.....	..	..	..	1
Syphilis.....	1	1	..	1
Severe anemia.....	..	1	..	..
Severe kyphosis.....	..	..	1	..

5. No significant difference was noted in the majority of cases between the pressure obtained after division of the lower end of the internal jugular vein and final division of the upper end.

6. The spinal fluid pressure obtained immediately prior to the patient's leaving the operating room showed no important variations between controls, first neck dissections, second neck dissections, and simultaneous bilateral neck dissections.

7. Postoperative spinal fluid pressure determinations revealed a rapid return to the normal level in both second neck dissections and simultaneous bilateral neck dissections. The highest pressure obtained

of these observations supports the contention that removal of the second internal jugular vein carries with it a minimum of hazard to the patient.

The only operative complications in the entire series were three cases of transient hypotension due to hemorrhage, all of which responded promptly to blood replacement. In no patient was there any indication of the livid facial cyanosis, irregular respirations, nasal bleeding, and exophthalmus which Sugarbaker has described as immediate sequelae of the ligation of a second internal jugular vein.⁸ The degree of postoperative cyanosis and edema after removal of the second internal jugular

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vein varied with the individual patient and in many cases showed little relationship to the height of the spinal fluid pressure. The most pronounced signs were frequently associated with pressure readings within normal limits, whereas a relatively high pressure could be found in others with minimal edema and cyanosis. In the group

or fourth postoperative day. Postoperative headache occurred more frequently in the simultaneous bilateral neck dissections than in the neck dissections performed as a second stage.

Although none of the patients in whom an interval of time had elapsed between radical neck dissections showed any un-

TABLE II.—*Spinal Fluid Pressures in MM. Water* in Patients with Operative Procedures in Regions Other Than Head and Neck (Control).*

Patient	On Side	Supine	Head Extended Posteriorly	Head Turned to Left	Head Turned to Right
J.B.....	150	175	175	200	180
J.T.....	80	150	150	500	260
C.K.....	170	160	185	195	200
G.W.....	110	130	200	240	240
V.R.....	100	100	100	130	150
F.S.....	140	150	160	170	160
F.A.....	150	175	175	190	200
L.G.....	80	100	110	140	150
B.T.....	100	110	120	180	180
G.P.....	140	150	160	190	190

*All determinations made prior to induction of anesthesia.

TABLE III.—*Spinal Fluid Pressures in MM. Water in Head and Neck Cases Without Radical Neck Dissection (Control)**

Patient	M.F.	H.P.	M.P.	P.A.	S.F.	L.K.	J.T.
Initial pressure (on side).....	120	80	80	140	50	100	80
Supine position.....	300	220	230	340	210	240	150
Head to side.....	...	260	260	...	270	260	260
After anesthesia.....	290	260	260	420†	280	280	...
Highest pressure during operation.....	...	300	400	420	460†	420†	...
Range of pressure during operation.....	...	95-	250-	280-	280-	230-	...
		300	400	420	460	420	
Final pressure.....	300	130	300	320	310	350	...

*The operations in this group were: one control on ward (without surgery), one direct laryngoscopy, one total laryngectomy and cervical esophagectomy, two resections of maxilla, one laryngectomy, and one partial laryngectomy.
†Patient coughing.

of second neck dissections included in the present series, a considerable degree of edema was present in seven patients and fairly marked cyanosis in three patients. The corresponding figures were seven and five respectively in the patients subjected to simultaneous bilateral radical neck dissections. An interesting observation was the delayed development of edema in several patients of both these groups, swelling of the facial structures being noted for the first time as late as the third

usual symptoms in the postoperative period, transient episodes suggestive of increased intracranial pressure interrupted the convalescence of two patients subjected to simultaneous bilateral dissections. One patient who had been out of bed in good condition the morning after operation suddenly developed a condition of marked cyanosis, loss of consciousness, clonic convulsive movements and incontinence in the afternoon of the same day. The attack lasted about two minutes, subsided with-

out treatment and was followed by a normal postoperative period with no repetition of the untoward incident. In the second patient, marked edema appeared for the first time on the fourth postoperative day associated with confusion and disorientation,

or the first postoperative day. The one exception was a 73-year-old cachectic male in poor physical condition prior to operation who died nine days after operation from the effects of aspirating nasal feedings (proved by autopsy). There was no indi-

TABLE IV.—*Spinal Fluid Pressures in MM. Water in First Radical Neck Dissections.*

Patient	T.P.	B.K.	W.G.	E.D.	R.L.	W.S.	A.T.	R.H.	D.J.	D.E.	Y.W.	J.T.	J.B.
Initial Pressure (On Side)	80	280	110	80	90	140	220	150	160	80	140	...	150
Supine	230	250	260	240	200	160	260	245	200	220	240	...	175
Head to Side	270	350	280	360	220	...	...	...	260	280	350	...	200
After Anesthesia	260	360	440	260	200	160	260	230	240	230	300	...	...
Lower End Internal Jugular Vein Divided	360	600†	360	420	...	600	380	340	480	240	300	505	400
Upper End Internal Jugular Vein Divided	410	300	360	540	...	600+	340	410	280	250	360	535	450
Highest Pressure During Operation	600+	600+	440	540	300	600+	380	410	600+	300	460	...	...
Range of Pressure During Operation	260-	210-	240-	260-	150-	160-	260-	230-	200-	220-	230-	...	...
Final Pressure	600+	600+	440	540	300	600+	380	410	600+	300	460	...	...
	400	220	250	600+*210	260	340	290	270	230	270	420	400	

*Patient coughing.

TABLE V.—*Spinal Fluid Pressures in MM. Water in Second Radical Neck Dissections.*

Patient	S.S.	B.B.	E.B.	A.P.	M.A.	E.P.	J.T.	J.B.	C.M.	M.L.	G.F.	G.H.	M.L.
Initial Pressure (On Side)	210	200	150	220	40	120	100	140	140	70	120	230	360
Supine	234	290	250	...	260	220	...	280	240	250	260	360	...
Head to Side . . . . .	...	...	...	...	...	290	...	340	320	300	260	...	...
After Anesthesia	390	...	...	340	200	...	...	260	240	300	...	360	...
Lower End Internal Jugular Vein Divided.	234	200	240	300	320	440	550	550	540	440	400	600+	320
Upper End Internal Jugular Vein Divided.	300	400	280	490	...	340	600+	600	280	400	400	540	460
Highest Pressure During Operation . . . . .	...	...	...	...	...	440	...	...	600+	580	490	600+	600+
Range of Pressure During Operation . . . . .	...	...	...	...	...	200-	...	...	260-	200-	300-	240-	320-
Final Pressure	280	250	220	460	430	300	530	600	340	300	340	250	380
Postoperative Pressure													
First P.O.D.	90	280	150	350	...	...	...	...	...	...	...	...	...
Third P.O.D. . . . .	...	...	...	...	...	...	125	150	...	...	...	...	...
Fifth P.O.D. . . . .	...	...	...	...	...	...	...	...	...	...	...	45	...

Lumbar puncture revealed a spinal fluid pressure of 340 mm. water which decreased to 240 mm. after removal of a small amount of fluid. Without additional therapy, his mental state cleared completely within 24 hours and he was discharged from the hospital in good condition. The relatively high spinal fluid pressure in this case differed from those obtained in the majority of other patients who developed marked postoperative edema and headache.

All but one of the patients in the entire series recovered promptly from anesthesia and were out of bed on the operative night

that removal of both internal jugular veins in itself contributed to his demise.

REVIEW OF SECOND NECK DISSECTIONS
1930-1950

Since the patients in this study were provided with release of excess pressure during operation via the continuous spinal needle and manometer, it was felt that a review of all the second neck dissections that had been performed on the Head and Neck Service of Memorial Hospital was indicated to determine whether there were any untoward effects in cases where a "safety valve" had not been employed.

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In the period from 1930-1950, 89 patients (69 male and 20 female) were subjected to removal of the second internal jugular vein at varying intervals after the first radical neck dissection. The patients ranged in age from eight to 80 years and were afflicted with the usual number of preoperative complications common to individuals in the middle and later decades of life (see Table VII). Although a few of the earlier cases were anesthetized with local infiltra-

dissections have been performed at Memorial Cancer Center without the use of a continuous spinal needle. No untoward reactions were noted during operation or in the immediate postoperative period. The one death that occurred was shown by autopsy to be due to aspiration of a nasal feeding several days after operation. No abnormalities related to removal of both internal jugular veins were found at post-mortem examination.

TABLE VI.—Spinal Fluid Pressures in MM. Water in Simultaneous Bilateral Radical Neck Dissections.

Patient	T.K.	G.B.	G.D.	A.K.	T.F.	E.K.	I.S.	O.A.	M.O.
Initial Pressure (On Side).....	...	...	20	100	180	180	...	120	140
Supine.....	...	...	160	210	250	...	...	240	170
Head to Side.....	...	...	180	240	300	...	...	280	340
After Anesthesia.....	150	260	220	220	280	380	240	220	340
Lower End Internal Jugular Vein Divided (1st. Side).....	390	300	280	380	330	540	...	540	350
Lower End Internal Jugular Vein Divided (2nd. Side).....	310	330	460	440	370	440	480	580	480
Upper End Internal Jugular Vein Divided (1st. Side).....	330	...	300	480	580	520	...	600+	380
Upper End Internal Jugular Vein Divided (2nd. Side).....	320	...	360	400	520	540	...	600+	480
Highest Pressure During Operation.....	500	420	480	600+	600+	...	...	600+	600+
Range of Pressure During Operation.....	150-500	260-420	180-480	220-600+	280-600+	...	...	240-600+	240-600+
Final Pressure.....	210	378	290	340	300	420	320	220	350
Postoperative Pressure									
First P.O.D.....	...	...	140	...	100	...	...	...	...
Second P.O.D.....	...	...	...	75	...	270	...	...	...
Third P.O.D.....	...	320	...	...	...	127	...	...	...
Fifth P.O.D.....	...	...	...	...	100	...	...	...	...

tion and cervical plexus block, Pentothal sodium was the agent of choice in the majority of patients in the series.

Complications in the operative and post-operative period were few in number. In addition to the varying degrees of cyanosis and edema which occurred in a large number of patients, three developed a severe headache and four presented symptoms which could possibly be attributed to increased intracranial pressure or laryngeal edema. A summary of the latter cases is shown in Table VIII. Severe laryngeal edema necessitated emergency tracheostomy on the ward in two other patients. There were no fatalities in the series and all patients were discharged from the hospital in good condition.

Since this study was completed, 12 additional simultaneous bilateral radical neck

DISCUSSION

The results described in the preceding section indicate that reports of severe morbidity and mortality following removal of the second internal jugular vein have not been confirmed by the experience of the Head and Neck Service of Memorial Hospital. Although an occasional patient exhibited symptoms and signs suggestive of a temporary state of increased intracranial pressure in the postoperative period, these episodes were of short duration and subsided spontaneously in the majority of cases.

A study of the anatomy of the intra- and extracranial venous system and of the dynamics of the cerebrospinal fluid circulation gives a clue to the many available compensatory mechanisms which permit successful removal of both internal jugular

veins. The venous drainage of the cranial cavity has been described in detail by Guis,² Sugarbaker⁸ and other recent investigators, so that only a brief review is indicated in this paper. In addition to the internal and external jugular veins, the major pathways from the head are the internal and external vertebral plexuses with their communicating veins, the occipital, posterior jugular, and profunda

toward the extracranial areas, thus reducing the venous congestion in the brain. This may account for the cases in which marked cyanosis and edema of the face are associated with a normal cerebrospinal fluid pressure and no evidence of increased intracranial pressure.

In addition to adequate collateral venous drainage from the brain, other factors may assist in preventing an untoward increase in intracranial pressure following removal of the second internal jugular vein. Weed⁹ and O'Connell⁶ have shown that, if a patient is placed in a reverse Trendelenberg (head elevated) position, there is a shift of cerebrospinal fluid to the lumbar region with an elevation of pressure in this area. The resultant partial collapse of the cranial portion of the cerebrospinal fluid system permits increased intracranial venous distention without a marked rise of intracranial pressure. An additional salutary effect is the probable greater rate of absorption of spinal fluid in the lumbar region due to the elevation of the hydrostatic pressure gradient.

A comparison of the spinal fluid pressure readings in the controls and unilateral neck dissections with those in patients subjected to a second radical neck dissection indicates that an increased pressure can be produced by factors other than division of a second internal jugular vein. A shift from the lateral to the supine position, turning the head to the left or right, coughing, or straining consistently produced higher readings in all groups. These observations confirm the results obtained in earlier experiments by Masserman⁵ and Hamilton.³ It is interesting to note that the increase in spinal fluid pressure produced by division of the internal jugular vein on the first side was usually as great as that resulting from the same procedure on the second side.

The exact etiology of the delayed onset of marked facial edema in a few cases is

TABLE VII.—*Preoperative Complications in Second Radical Neck Dissections 1930–1950.*

Complications	Number of Patients
Cardiovascular renal	
Coronary sclerosis	6
Essential hypertension	8
Hypertensive cardiovascular disease	15
Hypertensive renal disease	1
Pulmonary	
Chronic bronchitis and emphysema	6
Emphysema	4
Asthma	2
Pleural effusion	1
Arrested pulmonary tuberculosis	1
Neurologic	
History of cerebral accident	1
Metabolic	
Obesity	1
Hypothyroidism	2
Hypoparathyroidism	2
Diabetes mellitus	2
Cirrhosis of liver	1
Others	
Syphilis	3
Alcoholism	7
Senility	1

cervical veins, the collecting veins of the posterior cervical region and the pharyngeal, pterygoid and esophageal plexuses. Venograms performed by Guis by injecting Neo-Iopax into the frontal vein confirmed the extensive collateral venous system which remains after removal of both internal jugular veins. Batson¹ has estimated that the total cross-sectional area of the vertebral venous system alone probably exceeds that of the two jugular veins.

In the head itself, adequate communication exists between the intracranial and extracranial portions of the venous system. Shenkin, Harmel, and Kety⁷ have demonstrated that the flow of blood is mainly

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not known. It is conceivable that a reaction sufficient to produce temporary obstruction of the collateral venous drainage from the head may develop at the operative site by the third or fourth postoperative day.

Although the majority of second neck dissections and simultaneous bilateral radical neck dissections show no untoward reactions during the operative or postoperative period, the danger of laryngeal

inserted in the cases in the present series for the purpose of recording spinal fluid pressures, no untoward reactions were noted in either the second neck dissections or simultaneous bilateral neck dissections in which this measure was not employed. It has been our experience that any symptoms of increased intracranial pressure occur in the postoperative rather than the operative period, so the routine use of a continuous spinal needle is not considered

TABLE VIII.—*Complications of Second Radical Neck Dissections 1930-1950.*

Patient	Type of Complication	Time of Occurrence of Complication	Spinal Fluid Pressure	Treatment	End Result	Anesthetic Agent
1.	Hypotension, cyanosis, labored respiration, profuse oozing from wound	After division lower end internal jugular vein	145 mm. H ₂ O at end of operation	None noted	Recovered	Local (Procaine)
2.	Dyspnea, cyanosis	Middle of operation (unrelated to ligation internal jugular vein)		Tracheostomy	Immediate relief of symptoms	Local (Procaine)
3.	Apnea, marked cyanosis, marked hypotension	End of operation		Upright position, oxygen, transfusion	Recovered	Pentothal Sodium
4.	Drowsiness, respiratory depression, marked cyanosis, marked edema mild papilledema, hypotension	Third postoperative day	40 mm. H ₂ O on third postoperative day	Intravenous injection of 50 cc. 50% glucose	Symptoms started to subside on fourth postoperative day Recovered	Pentothal Sodium

edema and the occasional episode suggestive of increased intracranial pressure make it necessary to take certain precautionary measures. A tracheostomy is performed routinely in all patients subjected to removal of the second internal jugular vein. In view of the improved venous drainage from the brain and the salutary changes in the cerebrospinal fluid dynamics which occur in the "head up" position, it is probably advisable to employ this position in a modified form during the operative procedure as well as in the immediate postoperative period. The minimal changes in cerebrospinal fluid pressure produced by moderate extension of the head are not sufficiently important to warrant elimination of the folded sheets placed beneath the upper thorax to secure maximum surgical exposure.

Although a continuous spinal needle was

an essential factor for successful termination of these procedures.

No ill effects were observed from the use of a pressure dressing in any patient in the present series. However, in one simultaneous bilateral neck dissection performed at a later date than the group under consideration, loosening of the neck dressing seemed to improve the pronounced facial cyanosis and shallow respirations which were noted at the conclusion of operation. It seems wise, therefore, to check the condition of the patient immediately after application of the dressing so that appropriate measures may be taken to relieve any unusual symptoms.

If the precautions which have been outlined are followed in every case, clinical experience and investigation indicate that removal of the second internal jugular vein can be performed with a minimum of

hazard to the life and health of the patient. Although the immediate postoperative morbidity appears to be a little greater in simultaneous bilateral neck dissections than in staged operations, the successful outcome in patients in whom the former procedure has been done indicates that the risk is small and should not be a deterrent in cases where the clinical situation warrants the one stage procedure.

SUMMARY AND CONCLUSIONS

1. Spinal fluid pressure determinations were made in groups of patients subjected to radical neck dissection on the first side, second side, both sides simultaneously, and control operations.

2. These studies indicate that many factors in addition to removal of the second internal jugular vein produce elevation of the spinal fluid pressure.

3. Clinical experience with a large number of cases coupled with the result of these investigations proves that removal of the second internal jugular vein at the same or a later operation can be performed with minimal risk to the patient.

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