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Circling in Guinea Pigs with Lesions in the Brain Stem.

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Lurie[1] recently described circling or "waltzing" in guinea pigs; the circling was associated with deafness and the combined symptoms comprised an inherited characteristic of the recessive type. He concluded, since the peripheral vestibular mechanism was normal, that the circling was due to some disarrangement of a central nervous mechanism, probably in the region of the red nucleus.

Lurie and Dempsey[2] observed circling in guinea pigs with lesions in the interpeduncular region, immediately caudal to the mammillary bodies; a lesion on the left side of the midline induced circling to the right. They believed the circling in these animals to be due to a break in the normal reflex arc between the vestibular apparatus, the third nerve nucleus, and the postural centers.

The experimental observations and postulations of Lurie and Dempsey have made more significant some heretofore unreported observations on a group of my experimental guinea pigs. Circling has been one of the symptoms resulting from lesions in the medulla and pons in 13 animals; since the peripheral vestibular mechanism was intact and there was a break in the vestibulo-ocular reflex arc in each of these animals, a report of the phenomena seems warranted.

All the lesions were produced with Horsley-Clarke stereotaxic instruments and all were unilateral. Four were placed in the right side of the brain stem and the remaining 9 were on the left of the midline.

Tabulation of the observations (Table I) has revealed the interesting fact that circling was toward the side of the lesion in 6 animals and toward the opposite side in 7. Further analysis (see table) has shown a definite correlation, even in this small group of animals, between the location of the lesion and the direction of circling. Of those which circled toward the side of the lesion, 3 had involvement of Deiters' nucleus and 2 had lesions in the descending vestibular nucleus; the sixth in this group had partial destruction of the medial vestibular nucleus which was complicated by a second lesion in the medial nucleus of the cerebellum.

1 Lurie, M. H., *The Laryngoscope*, 1939, **49**, 558.

2 Lurie, M. H., and Dempsey, E. W., *The Laryngoscope*, 1939, **49**, 565.

TABLE I.
Circling in Guinea Pigs Following Lesions in Brain Stem.

Animal No.	Location of lesion	Side of lesion	Direction of circling	P.O. day first observed	Duration in days
1	D.Nu.; Desc.Nu.	Right	Right	5	1
2	D.Nu.; M.Nu.; J.R.B.	Left	Left	2	1
3	D.Nu.; M.Nu.	"	"	2	2
4	Desc.Nu.	"	"	2	4
5	Desc.Nu.	"	"	1	1
6	M.C.Nu.; M.Nu.	Right	Right	3	1
7	M.Nu.	Left	"	2	5
8	M.Nu.; M.R.F.	"	"	2	1
9	M.Nu.; M.R.F.	"	"	1	5
10	M.R.F.	"	"	2	1
11	M.R.F.	"	"	2	1
12	M.L.F.	Right	Left	1	5
13	M.Nu.; N.I.; D.Nu.; Desc.Nu.	"	"	2	3

Abbreviations: Desc.Nu.—Descending vestibular nucleus; D.Nu.—Deiters' nucleus; J.R.B.—Juxtarestiform body; M.C.Nu.—Medial cerebellar nucleus; M.L.F.—Medial longitudinal fasciculus; M.Nu.—Medial vestibular nucleus; M.R.F.—Medial reticular formation; N.I.—Nucleus interpositum (cerebellum); P.O.—Post-operative.

Circling toward the side opposite that of the lesion was brought about in one animal by a lesion confined to the medial vestibular nucleus, in 2 others by lesions in the same nucleus with concomitant involvement of the medial reticular formation, and in 2 by lesions entirely within the medial reticular formation. Another proved to have a lesion involving the medial longitudinal fasciculus at the level of the superior vestibular nucleus and the last animal in this group had the greatest amount of destruction in the medial vestibular nucleus with concomitant injury to the nucleus interpositum in the cerebellum, Deiters' nucleus, and the descending nucleus.

Lesions in Deiters' nucleus or in the medial nucleus most certainly interrupt the connections between the vestibular mechanism and the third nerve nucleus, thus supporting the theory presented by Lurie and Dempsey, even though they are at a more caudal level than the lesions produced by these workers. The lesion in the medial longitudinal fasciculus also interrupted the vestibulo-ocular reflex arc. On the basis of the reports by Lorente de No'[3] and others describing connections from the vestibular nuclei to the reticular cells and thence to the motor ocular nuclei, the assumption can be safely made that lesions within the reticular formation also disturb this same reflex arc. Furthermore, it is quite probable that the connections from the vestibular nuclei to the "postural centers" mentioned

[3] Lorente de No', R., *Ergebn. Physiol.*, 1931, **32**, 73; *Arch. Neur. and Psychiat.*, 1933, **30**, 245.

by Lurie and Dempsey are completed through the medium of the reticular cells.

Since I have been unable to demonstrate, in Marchi preparations, any ascending fibers in the medial longitudinal fasciculi which have their origin in the descending vestibular nuclei, either in cats[4] or in guinea pigs (unpublished observations), one must assume here, also, a connection with postural centers and motor ocular nuclei through the reticular cells. The more or less paradoxic direction of circling in the 2 animals (6 and 13), having lesions in the cerebellum and vestibular nuclei is probably explained by the complex interrelationship between cerebellum and vestibular nuclei.

Other postural defects, spontaneous nystagmus, etc., were also observed in this group of animals, similar to those reported elsewhere.[5]

The relatively short duration of the circling phenomena in most of the animals indicates an efficient compensatory mechanism. The late appearance of circling in animals 1 and 3 was due to their inability to assume the upright position previously. It is of interest that hypotonia, when it was evident, was always on the side of the lesion, even in those animals which circled to the opposite side.

Summary. Circling to one or the other side has been observed in 13 animals with lesions in the medulla and pons. Lesions in Deiters' and in the descending vestibular nucleus produced circling toward the side of the lesion, while those in the medial vestibular nucleus, in the medial reticular formation, and in the medial longitudinal fasciculus resulted in circling toward the opposite side. Since the connections between the vestibular mechanism and the motor ocular nuclei and possibly, those between the former and some postural centers were interrupted, these observations are reported as confirmatory of the hypothesis put forward recently by Lurie and Dempsey to explain the circling observed in their experimental guinea pigs.

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4 Buchanan, A. R., *J. Comp. Neur.*, 1937, **67**, 183.

5 Buchanan, A. R., *Monatschr. f. Psychiat. u. Neur.*, in press; *The Laryngoscope*, 1937, **47**, 874; *The Laryngoscope*, in press.