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Experience in 118 consecutive patients undergoing CT-guided stereotactic surgery utilizing the cosman-robert-wells (CRW) frame

Rashid Jooma
Aga Khan University, rashid.jooma@aku.edu

G. R. Sharma
Jinnah Postgraduate Medical Centre, Karachi

Experience in 118 Consecutive Patients undergoing CT-Guided Stereotactic Surgery utilizing the Cosman-Robert-Wells (CRW) Frame

G. R. Sharma, H. Siddiqui, R. Jooma
Department of Neurosurgery, Jinnah Postgraduate Medical Centre, Karachi.

Abstract

Aims: To evaluate the efficacy of CT-guided neurosurgical procedures done on patients operated by this modality.

Methods: Between January 1997 and March 2000, 118 patients undergoing CT-guided stereotactic procedures were recruited to the study. The CRW III stereotactic system (Radionics, USA) and the TSX-00ZA CT Scanner (Toshiba, Japan) were used for all the procedures in the series. These procedures were directed to symptomatic brain lesions or for the treatment of Parkinsonian tremor.

Results: Of 118 patients, 109 had intra-cranial lesions and 9 had Parkinson's Disease. The stereotactic procedures performed on these patients were: biopsies in 62, guided mini-craniotomies in 22, haematoma evacuation in 11 cases, aspiration of abscess in 8 cases, 2 biopsy/aspiration of cysts, 4 placement of catheters and 9 thalamotomies. A histological diagnosis was made in 98.15% while no diagnosis was reached in 1.85%. Morbidity and mortality were 5.92% and 2.55% respectively.

Conclusion: CT-guided stereotactic surgery using the CRW frame is accurate, quick, safe and highly effective (JPMA 53:214;2003).

Introduction

Advances in neuro-imaging techniques and improvements in stereotactic instrumentation have led to the increasing use of stereotactic surgery in the neurosurgical field. CT-guided stereotactic surgery is well recognized as a minimally invasive, low risk procedure with advantages for both the patient and neurosurgeon.[1-5]

The CRW (Cosman - Roberts - Wells) stereotactic system, was developed as a modification of the arc-radius design of the BRW (Brown - Robert - Wells) stereotactic system and utilises the existing fixation and fiducial components of the BRW system to localize and verify target data.[6,7] The CRW system is a target-centred arc design based on the Cartesian Principle. CT- guided stereotactic procedures using the CRW system have become well established in neurosurgery procedure and it is considered as one of the more simple, safe and reliable systems.[6,7] We studied 118 CT-guided stereotactic procedures using a CRW system in the Department of Neurosurgery, Jinnah Postgraduate Medical Centre, Karachi, Pakistan.

Patients and Method

One hundred and eighteen patients underwent CT guided stereotactic operations at our Institute between January 1997 and March 2000. All the patients underwent preoperative CT scans and some had preoperative MRI scans. Out of 118 patients, 109 patients had intracranial lesions and 9 suffered from Parkinsonian tremor. Thirty four patients were operated under general anaesthesia and 84 under local anaesthesia. Patients who were operated under general anaesthesia were either children or adults who underwent guided mini-craniotomies for lesion excision.

CRW III frame (Radionics, Burlington, MA, USA) and new generation TSX - 002A series CT Scanner (Toshiba, Japan) was used for all the stereotactic procedures and a Nashold side cutting needle for biopsy which takes out a core of tissue of approximately 10x1.5 mm. Less often, Gildenberg biopsy cup forceps which has a cup size of approximately 2x2 mm was used for hard granular and surface lesions, while a coil biopsy spring was used occasionally to acquire tissue from cyst walls. Intracerebral haematomas were evacuated using a three-way cannula with an Archimides screw device.

Preoperative MRI and CT scans were carried out in all the patients undergoing thalamotomy. Schaltenbrand and Wahren electronic brain atlas was utilized to determine the thalamic target coordinates during data acquisition. Physiological corroboration of the functional target was done using biopolar electrode with 1.1 mm diameter and 0.5 mm tip. Thalamic lesions have been made with a 3 mm bare tip of 1.1 mm diameter electrode using OWL Universal RF system (OWL instruments, Ltd, Markham, Ontario). Postoperative CT Scan or MRI were routinely performed to check the size and the location of the lesions.

Trajectory chosen for the stereotactic procedures were depended upon the site of the lesions and the nature of the procedure. Patients harbouring brainstem lesions were biopsied either via transfrontal or transcerebellar approaches. A pre-coronal entry point was selected for thalamotomies.

Tissue obtained from each of the intracranial lesions biopsied was submitted for histopathological examination. Post-operative scans were obtained whenever indicated. All the patients were regularly followed up post-operatively.

Results

Between January 1997 and March 2000, 118 patients underwent stereotactic procedures. There were 82 males and 36 females with age ranging from 5 to 70 years (Table 1). There were 21 children in this series, aged 5 to 16 years. Of the 118 stereotactic procedures; 62 were biopsies, 22 mini-craniotomies, 11 haematoma evacuation, 8 aspiration of abscesses, 2 biopsy/aspiration of cysts (with non-specific findings), 4 placement of catheters and 9 thalamotomies.

Table 1. Age distribution in cases of Stereotactic Surgery (n=118).

Age	No. of cases
0 - 10	11
11 - 20	14
21 - 30	20
31 - 40	18
41 - 50	23
51 - 60	25
61 - 70	7
Total	118

Table 2. Diagnosis of patients who underwent Stereotaxy (118).

Diagnosis	No. of cases	
Functional		
Parkinson's disease	9	
Non-functional		
Neoplastic		
Gliomas	57	(45 from biopsies, 12 from mini-craniotomy)
Metastasis	10	(7 biopsies, 3mini-craniotomy)
Primary CNS lymphoma	1	
	77	
Non neoplastic		
AVM	1	
Abscess	11	(8 aspiration, 1 biopsy, 2 mini-craniotomy)
Cotton Granuloma	1	
Cysts (4 placement of catheter	6	
1 archanoid		
1 inflammatory		
Fungal	3	
Haematoma	11	
Infarction/Necrosis	3	(1 biopsy, 2 mini-craniotomy)
TB Granuloma	5	(4 biopsies, 1 mini-craniotomy)
Total	118	

Of the 62 stereotactic biopsies, 50 were for supratentorial (of which 2 were temporal) and 12 for infratentorial lesions. Majority of patients undergoing stereotactic biopsy were diagnosed as glioma (45) and remaining were primary CNS lymphoma (1), metastases (7), fungal granuloma (3), tuberculoma (4), abscess (1) and infarction (1) (Table 2).

Twenty two patients underwent CT-guided stereotactic mini-craniotomy for gliomas (12), metastases (3), AVM (1), abscesses (2), cotton granuloma (1), tuberculoma (1) and infarctions (2).

Table 3. Anatomical Location of Lesions in Patients Undergoing Stereotactic Operation (n=109).

Anatomical locasion of lesion	No. of cases
Supratentorial (n=96)	
Lobar	
Frontal	19
Parietal	40
Temporal	7
Occipital	8
Basal Ganglia	10
Thalamus/Hypothalamus	12
Intratentoral (n=13)	
Mid brain	4
Pons	7
Cerebeller Hemispheres	2
Total	109

Out of 109 intracranial mass lesions, 96 were supratentorial and 13 were infratentorial (Table 3). In 105 patients (96.4%) the lesion was single and in 4 patients (3.6%) there were multiple lesions. Of the lesional cases, in 4 the intervention was for placement of a catheter in a cyst while a histological diagnosis was made in 103 cases (98.15%). A definite diagnosis could not be obtained in 2 cases (1.85%). The lesion was neoplastic in 68 cases (62.38%) and non-neoplastic in 35 cases (33.3%) (Table 4). The girl who had cotton granuloma was operated for convexity meningioma 8 years previously.

No complication was observed in 112 cases (94.08%). Over all morbidity and mortality, in this series, were 5.92% (7) and 2.55% (3) respectively. Two cases (1.7%) were complicated with intracerebral haematomas and both died within 48 hours of the stereotactic procedure. Two cases (1.7%) had developed brain edema, one died and one recovered with conservative management. One case (0.84%) developed diabetes insipidus which was controlled

Table 4. Histological diagnosis in patients undergoing Stereotactic Procedures (n=109).

I.	Neoplastic	68 (62.38%)		
1.	Glioma	57 (52.31%) - 45 biopsies, 12 mini-craniotomies		
	Grade I - II		21	
	Grade III		15	
	Grade IV		7	
	Pilocystic Astrocytoma		4	
	Gemistocytic Astrocytoma		2	
	Xanthoastrocytoma		2	
	Oligodendroglioma		3	
	Ganglioglioma		2	
2.	Primary CNS Lymphoma	1 (0.92%)		
3.	Metastases	110 (9.1%) - 7 biopsies, 3 mini-craniotomies		
	Adenocarcinoma		6	
	Melanoma		2	
	Large Cell tumour		1	
	Renal Cell tumour		1	
II	Non-neoplastic	39 (35.79%)		
	Abscesses		11	(8 aspiration, 1 biopsy, 2 mini-craniotomies)
	AVM		1	
	Cotton granuloma		1	
	Cysts (Non specific inflammatory)		4	(Catheter placements)
	Fungal Granuloma		3	(Biopsy)
	Haematomas		11	
	Infarctions		3	(1 biopsy, 2 mini-craniotomy)
·	TB Granuloma		5	(4 biopsy, 1 mini-craniotomy)
III	No diagnosis	2 (1.85%).		

with vasopressin.

Of 62 patients who underwent stereotactic biopsies complications encountered were one haematoma, one diabetes insipidus and two brain edema. The haematoma was evacuated successfully with stereotactic technique. Eleven patients with hypertensive intracerebral haematomas underwent stereotactic evacuation and one had re-accumulation of haematoma and died next day.

Nine patients underwent unilateral stereotactic thalamotomy for contralateral parkinsonian tremor. The tremor was abolished in 88.9% (8 cases) and one patient (11.1%) redeveloped tremor one month after the procedure. The rigidity was reduced in 66.6%. One patient developed transient hemiparesis and an other one chronic subdural haematoma, which was successfully evacuated at a later procedure. No death related to thalamotomy was observed.

No surgery related complications were noted among the patients who underwent stereotactic craniotomy, aspiration of cysts and abscesses and placement of catheter.

Discussion

In the present study, there was 100% accuracy of target localization. the non-diagnostic biopsy rate 3.1% was and this occurred predominantly in non-neoplastic lesions. The expectations of stereotactic biopsy are less for non- neoplas In our series, the morbidity and mortality following stereotactic procedure was 5.9% and 2.5% respectively; these rates are higher than those in literature where morbidity and mortality rates varied from 0.9% to 8.5% and 0 to 3.3% respectively.[1-5,8,9,12,14-17] Although the complication rate in this series is on the higher side, they compare favourably with the complication rates of other large series. Wild reported 8.5% morbidity and 1% mortality.[12] Kelly in 547 cases reported 2.9% morbidity and 0.3% mortality[4], Barnstein in 300 cases, reported 4.7% morbidity and 1.7% mortality[2] and Gomez and Barnett observed 10.8% morbidity and 0% mortality in their series.[3] High mortality was observed in Bosch's series which was 3.3%.[14] Haemorrhages accounted for the majority of morbidity and death in previous series.[2,5,8,10,12,14,16-19] Other deaths were due to brain edema and herniation.[4,11,16] Same pattern of complications were noted in this series; they were haemorrhages (1.7%), brain edema (1.7%), neurological deficit (0.84%) and diabetes insipidus (0.84%). In our series there were two deaths from haematoma and one death from brain edema. These two patients who died of post-operative haematoma had similar solid, vascular and brilliantly enhancing lesions that were supplied directly from the anterior and middle cerebral arteries.

Of 11 patients with hypertensive intracerebral haematomas who underwent stereotactic evacuation, one died of rebleeding. Even with stereotactic evacuation, the operative results of hypertensive intracerebral haematomas have been unsatisfactory.[20-32] In Matsumoto's series complication associated with stereotactic aspiration of haematoma was 9.3% and post-operative re-accumulation of haematoma occurred in 5%.[28] Previous experiences have shown that with stereotactic method, 20 to 80% haematomas can be removed.[28,29,33] Backlund and Von Holst[20] and Higgins and Nashold[23] independently devised a double aspiration cannula, on the basis of the water - screw principle of Archimedes to remove the clotted blood. Even with this method, it is not possible to eliminate the haematoma completely. Matsumoto could remove up to 50% haematoma.[28] In our series, 60-70% of haematoma was evacuated using Archimedes screw device and this result is promising compared to the results of previous series.[28,31-34]

In our series, 9 patients underwent thalamotomy and tremor was abolished in 88.9%. The tremor re-occurred in one patient (11.1%) a month after the thalamotomy. Rigidity was reduced in 66.7%. Two patients developed complications; one suffered from transient hemiparesis and another developed chronic subdural haematoma. Our results are better than those of others. Jancovic reported disappearance of tremor in 86% and 58% suffered complications, 23% of which were persistent.[35] Siegfried and co-workers, reported complete disappearance of the tremor on the side contra-lateral to surgery in 85% and rigidity was considerably improved in 80% of the cases[36] with morbidity of 25% and mortality of 0.70%. Tasker reported abolition of tremor in 80% of the patients with significant persistent tremor in 10-15%.[37] Goldmann, reported complete disappearance of tremor in 75% and permanent complication in 14%.[38] Likewise, Fox performed thalamotomy in 36 patients with parkinsonian tremor and obtained success rate of 86% with transient complications in 14% and permanent complications in 5%.[39]

CRW stereotactic system is based on 'centre of arc' design and was developed as a method of transforming the two dimensional CT data into three dimensional data related to a reference plane fixed to the skull. The CRW system has the advantage of allowing an infinite number of predetermined entry points, permitting the surgeon to use any entry point for a given target, as well as having capability to approach multiple target sites through the same entry point. These entry points can be chosen to avoid eloquent and vascular areas of the brain. Other major advantage of the CRW is that the arc may be rotated clear of the immediate operative field and re-introduced at anytime without loss of target localization. During the procedure, the target co-ordinates can be changed for a new target without a break in the sterility. The CRW system allows direct lateral approaches to any target because the arc side rings can be transposed from left to right orientation on the base plate to the anterior and posterior position. This is particularly useful for the temporal approaches for biopsy and craniotomy of the temporal lesion. The CRW system allows transfrontal and transcerebellar approaches for the biopsy of brain stem lesions to be carried out with ease. For the transcerebellar approaches, the base ring must be positioned low enough to allow the trajectory to the brain stem lesion. The CRW arc is easily positioned for posterior fossa surgery, as the probe holder can extend close enough to the frame to allow consistent suboccipital access. All these advantages of the CRW system makes this system suitable for stereotactic biopsy, craniotomy, thalamotomy, haematoma evacuation, aspiration of abscesses and cysts and placement of the catheter with minimum morbidity.

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