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Research Article

Telemedicine in Follow-up after Spine Surgery: Need of the Hour

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Abstract

Purpose There is an acute shortage of neurosurgeons and spine surgeons especially in rural areas of low- and middle-income countries including India. Patients of spine surgery need to travel long distances for follow-up at tertiary care hospitals. This study was done to evaluate role and success rate of telemedicine in follow-up after spine surgery based on patients' diagnosis and demographic features and to identify barriers to successful telemedicine consultations.

Methods All patients undergoing spine surgeries including craniovertebral junction (CVJ) surgeries from January 2021 to June 2022 were included in the study. Success rate of telemedicine was calculated using a simple formula: Success rate of telemedicine = successful telemedicine consultations / total number of telemedicine consultation $\times$ 100. Success rate was evaluated with respect to demographic features and underlying disease-related factors.

Results Eighty-four patients formed the study group in which a total of 181 video teleconsultations were done. Overall success rate of telemedicine was 82.87%. Higher socioeconomic and educational statuses were related to higher success rates of teleconsultations ($p < 0.05$). Difficulty in assessing neurological condition using video call in follow-up cases of CVJ and issues related to Internet communication network leading to inability to video call and share image/videos were major causes of failures.

Conclusion Telemedicine may prove an effective option for following up patients undergoing spine surgeries except CVJ, which is likely to improve further with improvements in Internet connectivity.

Keywords
- telemedicine
- teleconsultation
- spine surgery
- follow-up

Introduction

There is an acute shortage of neurologists and neurosurgeons in India and globally.[1] There has been an exponential increase in the growth and development of information and communication technology (ICT) especially in the last decade.[2] Plummeting costs and unbelievable sophistication in the availability of user-friendly mobile connectivity and mobile applications supporting image/video sharing have opened up tremendous scope of telemedicine in all aspects of healthcare services.[3] However; its application in healthcare service is relatively slow especially in low- and middle-income countries (LMICs).[4] In the last decade,

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however, specialists in all branches of neurosciences are slowly accepting that telemedicine must and will have to be incorporated into the core of the healthcare delivery system.[5] Coronavirus disease 2019 (COVID-19) has further opened up the new era of fast growth of teleconferencing and use of ICT in healthcare services.[5] Employing available telemedicine technologies is a strategy that can bridge care gaps and improve the access to the services for patients who can be cared for without them visiting a regional specialty center.[6] Majority of spine surgeons work in urban settings and the majority of rural areas lack access to treatments of spine ailments and telemedicine may become crucial for these diseases.[7] In a big nation like India, where the bulk of the population lives in distant areas without access to even the most basic healthcare, telemedicine may offer significant benefits.[8]

We carried out this study is to evaluate role of telemedicine in follow-up after spine surgery including craniovertebral junction (CVJ), to correlate success rate of telemedicine with patients' diagnosis and demographics, and to identify barriers for successful telemedicine consultations (TC).

Materials and Methods

Study Design

It was a prospective, nonrandomized, observational, cohort study.

Study Participants

All patients undergoing spine surgeries from January 2021 to June 2022 participated in this study.

Inclusion Criteria

All patients undergoing spine surgeries including CVJ surgeries were included in this study.

Exclusion Criteria

Patients not willing to participate in the study, patients not having at least 2 TC and minimum 6 weeks of clinical follow-up, and patients without access to necessary ICT were excluded from this study.

All patients fulfilling the inclusion criteria were serially included for the study, by consecutive sampling, until at least the desired sample size was achieved. A retrospective analysis of follow-up patients undergoing spine surgeries (emergency/elective spine surgeries including CVJ) was done starting from January 2020 to October 2020. A retrospective pilot study was conducted on 15 patients with success rate of 80%. Using a 95% confidence interval and 10% absolute error, sample size was determined to be 60.

Scientific committee and institute ethics committee approval was taken prior to commencement of the study. Written informed consent was taken from all participants or their next of kin. Data was collected using a predesigned, semistructured proforma (►**Fig. 1**). Socioeconomic statuses of the study group were assessed as per Modified Kuppuswamy Scale.[9] All enrolled patients' TC follow-up was done at suitable intervals

Proforma for patients

Serial number:

Demographic details

- Name: Age/sex:
- Hospital number: Contact number:
- Socioeconomic status (Modified Kuppuswamy Scale)
- Educational status
- Address (with mobile number)
- Comorbidities
- Preoperative complaints
- Preoperative positive clinical findings
- Clinical diagnosis
- Radiological diagnosis

Operation details

- Date of surgery:
- Surgery performed:
- Surgical approach:
- Intraoperative findings:

Postoperative:

- Complaints
- Positive clinical findings

Follow up:

- Platform for teleconsultation: WhatsApp video call/ skype/ zoom
- Follow up duration:
- Assisted clinical examination by: Patient / relative/ healthcare worker
- Complaints
- Positive clinical findings
- Remark: successful or unsuccessful telemedicine consultation
- Reason for unsuccessful telemedicine consultation (if applicable):

Fig. 1 Proforma for recording patients' demographic, radiological, and clinical details.

depending on patients' condition and underlying problems, most commonly 2 weeks and 3 to 6 months after discharge. Valuable information was gained by asking the patient about current complaints, bladder and bowel habits. Patients were asked to demonstrate gait and power; sensations of the patient were checked with the help of patient's attendant/local healthcare worker over a video call. A dermatomal pain diagram was given to patient/attendant for reference at the time of discharge (►**Fig. 2**), as well as a video demonstration of the examination technique was done (►**Fig. 3**).

A TC was considered "successful" if the patient and doctor were satisfied with the teleconsultation without requiring in-person visit for further evaluation or treatment. It was considered "unsuccessful" if the patient needed to undergo in-person visit follow-up because of any of the reasons like technological issues, further evaluation, or patient's choice for in-person visit or other reasons. TC was considered "successful" when it was possible to assess gross motor power, sensory functions of limbs and bladder/bowel functions and the patient's clinical condition was either

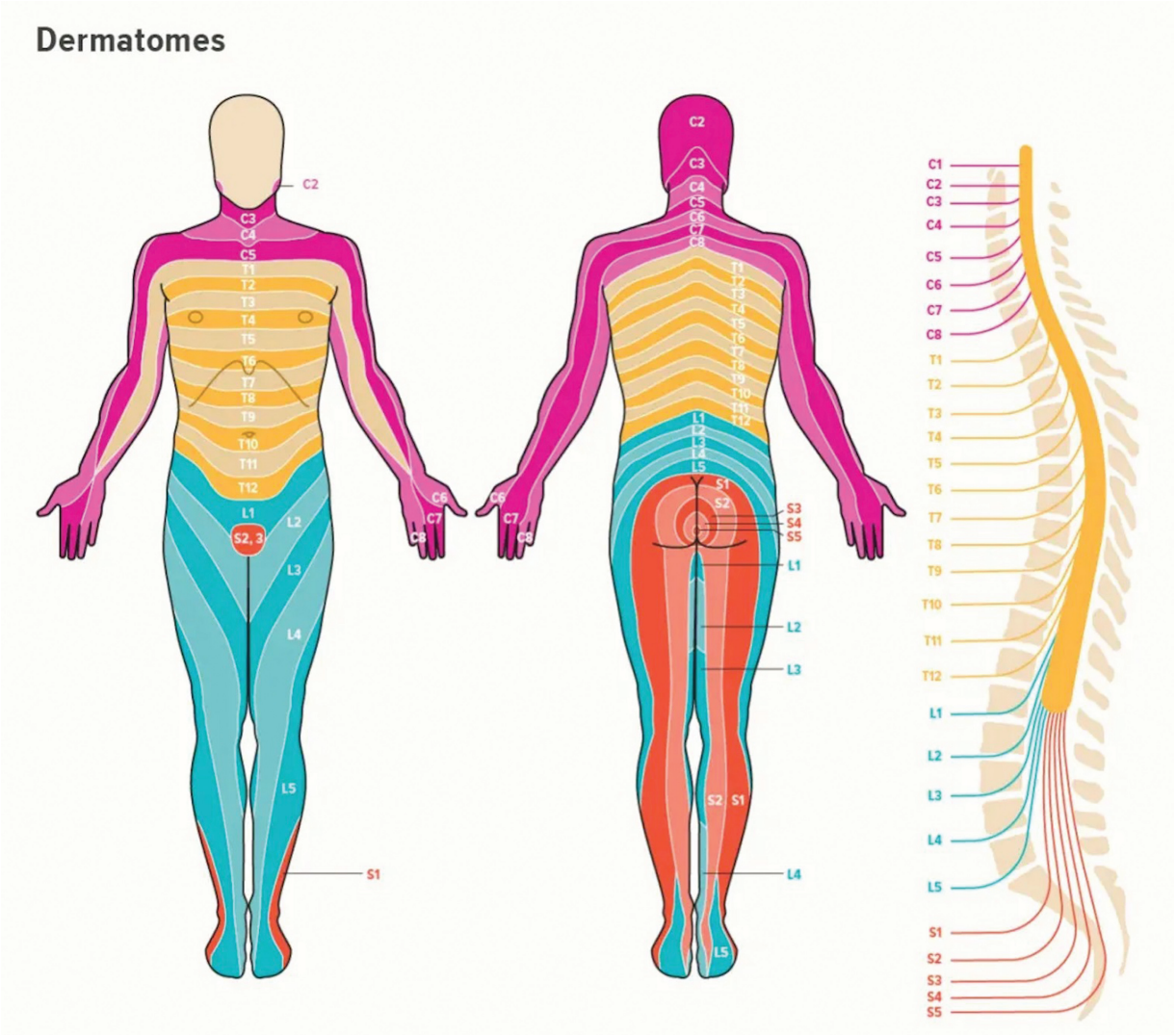

Fig. 2 Dermatome diagram that was explained and handed over to the patient/relative at the time of discharge.

stationary or improving. Success rate of TC was calculated by following formula: Success rate of TC = Successful TC/Total number of TC x 100.

Results

During the study period, a total of 139 patients were assessed for eligibility. Of these, 84 patients satisfied the selection criteria and were included in the study. The other 55 patients either did not participate or lost to follow-up.

Demographic and clinical profiles of the study group are summarized in ►**Table 1**. Most of the patients were married (79%), belonged to rural area (79%), were educated (53.57%), were without pre-existing morbidity (81.76%), and residing more than 100 km (60.71%) from the institute where the study was carried out. Average distance of patients from the institute was 196.2 km and total distance of all patients together was 16,677 km. Total travel distance saved with successful TC was 12,322 km. Commonest category of disease was degenerative (61.9%) and lumbar spine was the commonest spine segment (44.04%) of surgery. ►**Fig. 3** shows age groups of the study group and most of the patients belonged to the age ranging from 21 to 50 years (56%). The mean age of the study population was 40.42 years (range: 1–81 years).

►**Table 2** shows socioeconomic status of the study group and majority of the study population belonged to the upper lower class (34.5%), followed by the lower middle class (30.95%). Only 4.74% patients belonged to the upper-class family.

►**Table 3** summarizes results of TC based on demographic variables. Overall success rate of telemedicine was 82.87%. Success rates in first, second, and third TC were 89.28, 78.57, and 69.23%, respectively. It was more successful in the male (87.91%) than the female (77.77%) patients. As per socioeconomic status, maximum success of TC was observed in the upper class (100%), followed by upper middle (87.5%), lower middle (83.6%), and lower class (44%) patients and socioeconomic status was significantly associated with the success of TC ($p < 0.05$). Educational status of the head of the family was significantly associated with the success rate of the patients ($p < 0.05$). Success rates of TC were 41.66, 72.72, and 100%, in patients when patients' head of the family was illiterate,

Fig. 3 Teleconsultation video calls in spine follow-up. (**A**) Examination of craniovertebral junction patient with the help of a relative. (**B**) Examination of postoperative patient of cervical laminectomy for cervical canal stenosis due to ossified posterior longitudinal ligament. (**C**) Examination of motor power with the help of a relative in a patient who had undergone dorsal laminectomy for hypertrophied ligament flavum.

educated up to primary school, or had a professional degree, respectively. Patients with degenerative disease (80.53%) and CVJ surgery (73.91%) were associated with the lowest success rate, which was not significant. All TCs were done using WhatsApp messenger (WhatsApp LLC, California, United States) video calling platform. All TCs were done by single resident doctor in the department of neurosurgery and it was supervised by a faculty member.

►**Fig. 4** summarizes causes of failure of TC. First TC was done at 2 weeks of interval. During first TC, issues related to ICT (77.77%) were an important cause of failure of teleconsultation. Further physical visit for evaluation/treatment was felt necessary in 22.22% of patients as detailed examinations such as checking deep tendon and superficial plantar reflexes were not possible on video calls. As most of second TCs were done at an average of 3 months when many patients were advised for follow-up imaging to look for fusion in case of fixation or recurrence in tumor, most common reason for unsuccessful second teleconsultation was difficulty in sharing follow-up radiological imaging studies (58.8%). Physical visit after second TC for clinical evaluation was considered necessary in 29.41% of patients for detailed neurological examination, while ICT-related problem was present in 23.52% of unsuccessful TC. Third TC was done at an average of 4 to 6 months and the commonest reason for unsuccessful third TC was either difficulty in sharing follow-up radiological imaging studies (50%) or ICT-related problem (50%).

Discussion

Spinal disorders are associated with a considerable healthcare burden and the need for frequent specialized medical consultations for symptomatic management.[10] Before COVID-19 pandemic, limited spine practices utilized telemedicine. Several challenges impeded adoption, including a lack of perceived benefit, technology implementation costs, difficulty diagnosing musculoskeletal disorders, and concerns regarding reimbursement and liability.[11] During the pandemic, however, as many as 35.6% of spine surgeons worldwide were performing over half of their clinical visits via telemedicine.[12,13]

Neurological examination is the one of the most challenging among all other systemic clinical examinations mainly due to complexity and skills required for evaluation of higher mental function, cranial nerves, lobar functions, and cerebellar functions.[14] Clinical evaluation of spine disorders, that too in follow-up, excludes practically all the above-mentioned complexities related to the neurological examination, except in CVJ patients.[15] It was relatively easy to explain even illiterate patients/relatives about "Dermatomal Sensory distribution diagrams," see patients on video call how they move their limbs or ability/inability to walk. Currently, 66.2% of Indian population use smartphone with 825.3 million Internet users and 487.5 million Indian use of WhatsApp mobile application.[16]

Most of the patients in the study were residents of places which were more than 100 km from the tertiary care institute where the study was conducted. A total travel distance of 12,322 km was saved with successful TC in our study, could result in 1,763.2 kg less CO_2 (carbon dioxide) emission.[17]

Success rates were higher in patients who belonged to higher socioeconomic status as per the modified Kuppuswamy scale and who had higher educational status and both of these factors were statistically significant. Study was done in

Table 1 Demographic variables, diagnoses, and spine level of surgery of the study group

Demographic variables		No. of patients (%)
Gender	Male	42 (50)
	Female	42 (50)
Marital status	Married	66 (79)
	Unmarried	18 (21)
Residence area	Rural	66 (79)
	Urban	18 (21)
Educational status of patients	Educated	45 (53.57)
	Illiterate	33 (39.28)
	Not applicable	6 (7.14)
Preexisting co morbidity	Yes	18 (18.24)
	No	66 (81.76)
Distance from hospital (km)	<100	33 (39.29)
	100–200	30 (35.71)
	200–500	17 (20.25)
	>500	4 (4.76)
Indication of surgery	Degenerative	52 (61.90)
	Congenital	16 (19.04)
	Tumor	13 (15.47)
	Trauma	3 (3.57)
Level of surgery	Craniovertebral junction	11 (13.09)
	Cervical	23 (27.38)
	Dorsal	13 (15.47)
	Lumbar	37 (44.04)

Table 2 Socioeconomic details of the study group as per the Kuppuswamy scale

Socioeconomic scale	Aspects	No. of patients (%)
Education of head of family	Illiterate	12 (14.28)
	Primary	15 (17.85)
	Middle	13 (15.47)
	High school	26 (30.95)
	Intermediate/diploma	11 (13.09)
	Graduate/ professional degree	7 (8.33)
Occupation of head of family	Unemployed	2 (2.38)
	Unskilled worker	18 (21.42)
	Semiskilled worker	11 (13.09)
	Skilled worker	18 (21.42)
	Clerical/shop/farm	24 (28.57)
	Semiprofessional	6 (7.14)
	Professional	5 (5.96)
Per capita income (per month)	≤1,146	15 (15.85)
	1,147–3,404	29 (34.52)
	3,405–5,675	16 (19.04)
	5,676–8,512	9 (10.71)
	8,513–11,350	9 (10.71)
	11,351–22,702	4 (4.7)
	≥22,703	2 (2.38)
Based on class	Upper class	4 (4.76)
	Upper middle class	14 (16.66)
	Lower middle class	26 (30.95)
	Upper lower class	29 (34.52)
	Lower	11 (19.09)

the western state of India, which is one of the least densely populated states of the country.[18] Similar experience has been reported in earlier study too due to audio- and video-related issues.[19] Our study is unique in following of spine surgery patients only and also all the follow-ups were done using video calls, whereas other studies have used both audio and video calls.[19] We feel that follow-up using video calls are much more informative than audio call follow-up.

Government of India has already launched fifth-generation mobile network (5G) services which is expected to grow in coming few years and will have its favorable effects on digital services including telemedicine.[20] Issues related to ICT, if solved, will greatly affect the outcome. Another issue related to sharing of radiological images was poor quality of photos of X-rays, computed tomography scan, or magnetic resonance imaging films that were taken without using view-box. This issue could have been solved by taking help of local radiological diagnostic centers where view-boxes are available. Failure of TC was maximum in patients who had undergone CVJ surgery, though not significant. It was mainly due to the need to examine lower cranial nerves and respiratory function in addition to upper and lower limb examinations, which were difficult for the relatives to demonstrate.

Several studies have demonstrated the feasibility, cost reduction, satisfaction, and effectiveness of telemedicine for patients with spinal disorders.[6,12,21] However, most were conducted in developed countries, had strict inclusion and exclusion criteria, or were performed using protocols that would facilitate telemedicine through the provision of the technological means necessary for it and instructions on how to use them. It is unknown how feasible it is to locate patients with spine disorders and perform TC for them in developing countries, such as India, where limited access to the technological means to undergo a TC or video consultation or a low level of schooling could hinder this modality of care.

Slight younger age of the study group, comparable gender distribution, and marginally less patients in the upper-class category were the few features different from the earlier study.[19] Success rates of TC in our study were less than few earlier studies.[5,6,19,21] Success rates were not significantly different in first, second, and third visits and also was not different based on sex of the patients. Barring CVJ, it was also not affected by diagnosis and spine level of surgery. No other

Table 3 Results of teleconsultation based on demographic variables, types of visit, diagnoses, and treatment of the patients

Patient demographic data		Successful (%)	Unsuccessful (%)	Total	Chi-square	*p*-Value
Type of visit	First visit	75 (89.28)	9 (10.71)	84	5.233	0.073
	Second visit	66 (78.57)	18 (21.42)	84		
	Third visit	9 (69.29)	4 (30.76)	13		
Sex	Male	80 (87.91)	11 (12.09)	91	3.274	0.070
	Female	70 (77.77)	20 (22.23)	90		
Socioeconomic status	Lower	11 (44)	14 (56)	25	35.54	<0.0001
	Upper lower	51 (83.60)	10 (16.4)	61		
	Lower middle	49 (87.5)	7 (12.5)	56		
	Upper middle	30 (100)	0 (0)	30		
	Upper	9 (100)	0 (0)	9		
Educational status	IL	5 (41.66)	7 (58.34)	12	21.78	0.0006
	PS	24 (72.72)	9 (27.28)	33		
	SS	21 (77.77)	6 (22.23)	27		
	HS	61 (89.70)	7 (10.30)	68		
	I	22 (91.66)	2 (8.34)	24		
	D	9 (100)	0 (0)	9		
Indication of surgery	Degenerative	91 (80.53)	22 (19.47)	113	2.494	0.476
	Congenital	28 (83.60)	6 (16.4)	34		
	Tumor	25 (87.5)	3 (12.5)	28		
	Trauma	6 (100)	0 (0)	6		
Level of surgery	CVJ	17 (73.91)	6 (26.09)	23	4.304	0.230
	Cervical	44 (91.66)	4 (8.34)	48		
	Dorsal	23 (79.31)	6 (20.69)	29		
	Lumbar	65 (81.25)	15 (18.75)	80		

Abbreviations: D, Graduate Degree holder; IL,—; I, illiterate; CVJ, craniovertebral junction; HS, high school; PS, primary school; SS, senior secondary.

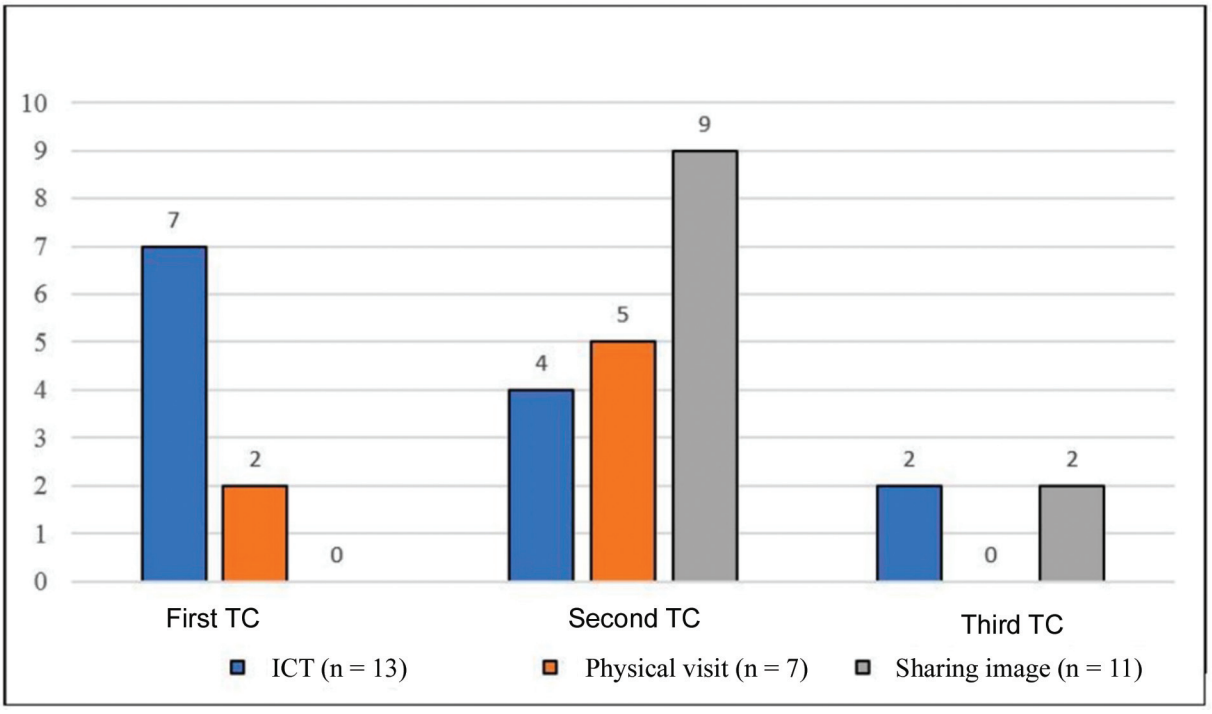

Fig. 4 Causes of failure of telemedicine consultation (TC). ICT, information and communication technology.

study in previous literature has compared success rate of TC with demographic factors and clinicoradiological diagnosis.

Conclusion

We conclude that TC may prove an effective method for follow-up of patients undergoing spine surgery. Patients who undergo surgeries of CVJ may not be a good candidate for follow-up by TC. Better availability of Internet access in near future may help in higher rates of success of TC.

Note
This study was presented at 10th AIIMS Annual Spine workshop (AASW), 2022, at New Delhi, India on September 9, 2022.

Conflict of Interest
None declared.

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