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Remote treatment of pectus carinatum (Telepectus) during the COVID-19 pandemic

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ABSTRACT

Background/Purpose: To report telemedicine's feasibility and satisfaction rates for treating patients with pectus carinatum using a dynamic compressor system. We analyzed treatment adherence in comparison with the previous, non-pandemic year.

Materials and methods: Retrospective analysis including patients with pectus carinatum under treatment with a dynamic compressor system using telemedicine at the chest wall centers from two hospitals, private and public, between April and July 2020. A free video conference platform for teleconsultations was employed. We evaluated the incidence of pectus cases with telemedicine, the number of dynamic compressor system prescriptions, the number of patients in the correction phase, and the number who ended treatment. To assess adherence, we compared our cohort with an in-person cohort during the same time frame of the previous, non-pandemic year. In addition, we performed a patient satisfaction survey comprising questions related to socioeconomic status, the likeability of telemedicine, simplicity of modification of the system, and desire to continue with telepectus after the pandemic.

Results: One hundred and thirty-six telepectus consultations were performed in 76 patients. During this time frame, 15 patients started using the dynamic compressor system. Compared to the previous, non-pandemic year, the number of consultations per patient was similar (2019: 1.92 ± 1 .0 vs. 2020: 1.79 ± 0.8, $p = 0.32$), and there was a significant reduction in the number of dropouts with the use of telemedicine (9% vs. 1%, $p = 0.025$). Fifty-nine patients answered the satisfaction survey. All of them solved their doubts through telemedicine. Overall, 95% found telemedicine comfortable. Of note, those with a lower income evidenced the highest intention in continuing with telemedicine.

Conclusions: We demonstrated the feasibility of remote care of patients with pectus carinatum using a dynamic compressor system with a similar frequency of consultations compared to in-person medical care. Telepectus patients revealed a high rate of satisfaction irrespective of their socioeconomic status.

Level of evidence: IV.

Type of study: Retrospective study.

1. Introduction

Since the COVID-19 pandemic outbreak, social isolation was established, and in-hospital follow-up was interrupted. Consequently, although the effectiveness of telemedicine had already been tested and demonstrated in different clinical scenarios [1–3], its application experienced massive global growth.

In the field of pediatric surgery, few reports have been published on telemedicine. Most of them analyze the potential uses and benefits that would bring to patients in the future and encourage its development. More recently, after the pandemic and a major development in this field, many surveys were done to patients that were attended through this tool showing rates of satisfaction higher than 80% [4].

In this context, we created a Telepectus program comprising telemedicine for diagnosing, treating, and following patients with chest wall deformities in this setting.

We aimed to report telemedicine's feasibility and patient satisfaction rates for the treatment of patients with pectus carinatum using a dynamic compressor system. We also evaluated the extent of treatment adherence in comparison with the previous, non-pandemic year.

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Table 1
Comparison between telemedicine group and controls.

	Telemedicine ($n = 76$)	In-person consultations ($n = 154$)	p
Age (years)(mean / standard deviation)	15.1 ± 3.9	14.7 ± 4.0	0.51
Gender			0.12
female ($n = 40$)	9(23%)	31 (77%)	
male ($n = 190$)	67 (35%)	123 (65%)	
Mean number of consultations per patient	1.79 ± 0.8	1.92 ± 1.0	0.33
Reference center			0.001
Public (number of visits, $n = 99$)	45 (46%)	54 (54%)	
Private (number of visits, $n = 131$)	31 (24%)	100 (76%)	
Severity of the defect (Initial correction pressure in PSI)	7.5 ± 2.6	6.9 ± 2.9	0.19

2. Materials and methods

We performed a retrospective analysis including patients with pectus carinatum using telemedicine at two healthcare medical centers, one public and another private, between April and July 2020.

We evaluated the number of new pectus cases with telemedicine (initial consult), patients in the correction phase (follow-up), patients who ended treatment (correction or failure), and dropouts. A dropout was defined as the patient who missed 2 consecutive visits (i.e., 2 months or more). The number of prescriptions of dynamic compressor systems was also calculated.

To assess patient's adherence, we evaluated a retrospective cohort of patients under treatment at our clinics during the same time frame of the previous, non-pandemic year. This control group is comparable in age, gender, and severity of the defect, as shown in Table 1.

A survey assessing patient satisfaction rates was performed, including all patients with pectus carinatum in the telepectus program during the study period.

This study was approved by the Institutional Review Board (IRB) of Fundación Hospitalaria, Buenos Aires, Argentina, and the patient's consent to publish the results was obtained.

3. Pectus carinatum treatment

As previously reported, the same treatment protocol was used in both centers and study periods [5]. This protocol has an effectiveness rate between 88% and 96% [5,6], and it is used, over 90% of the patients with pectus carinatum are treated with a non-operative approach using a dynamic compressor system. In brief, after pectus carinatum diagnosis and using a specially designed measuring device, the pressure of initial correction (PIC) was calculated (Fig. 1). PIC stands for the pressure required to completely correct the deformity by exerting a force on the chest in pounds per square inch (PSI). Candidates for treatment with the dynamic compressor system were selected depending on PIC and the patients' characteristics [7]. Next, using surface images provided by an optical scanner, a customized dynamic compressor system was manufactured (®FMF Dynamic Compressor System, Pampamed, Buenos Aires, Argentina). Patients were instructed to wear the device as much time as possible, except when practicing sports. Further adjustments were made during monthly visits until a complete correction was achieved [5]. The workflow of both groups is shown in Fig. 2.

4. Technical aspects

We used a videoconference platform with a waiting room (©2021 Zoom Video Communications, Inc.). A brochure with indications for the platform's correct use and a checklist of required instruments were sent in advance. During the teleconsultation, the physician evaluated the fit of the dynamic compressor, calculated the necessary adjustments, and guided the patient in modifying the dynamic compressor system as necessary (Fig. 3).

5. Satisfaction survey

We performed a post-hoc patient satisfaction survey to assess the perception of telemedicine among our pectus carinatum patients. It included questions about comfort, clarity of instructions, simplicity of modification of the systems, and the likeability of telemedicine. In addition, demographics of the patient population and impact according to social-economic status were also inquired on and analyzed.

6. Statistical analysis

Continuous variables were reported as means ± standard deviation and median (interquartile range, IQR), and categorical variables were reported as counts and percentages. Differences between groups were evaluated using independent samples T-test for continuous variables and chi-square tests for categorical variables. Statistical analyzes were performed using SPSS software, version 22.0 (IBM SPSS Statistics for Windows, Armonk, NY).

7. Results

One hundred and thirty-six teleconsultations were made in 76 patients with an average of 1.8 ± 0.8 consultations per patient. Thirty-one (40, 7%) were done from a private hospital and 45 (59, 3%) from a public hospital. Gender distribution comprised 67 males (88%) with a median age of 15.1 years (interquartile range 7–19 years).

During the study period, we performed 12 initial consultations, and 15 patients began using the dynamic compressor system. Also, 49 (64, 4%) patients in the correction phase of pectus carinatum using the dynamic compressor system were treated using telemedicine, 46 (94%) were able to adjust the system remotely. Moreover, 22% of the patients that was in follow-up achieved complete correction of their pectus carinatum during the study period.

There were no significant differences in terms of age and gender between patients from a public and a private hospital (median age 15 for both, 86.7% male in public hospital vs. 90.4% in private).

Compared to the same period of the previous non-pandemic year, the total number of patients decreased (2019: 155 vs. 2020: 76). Still, there were no significant differences in terms of the number of consultations per patient (2019: 1.92 ± 1.0 vs. 2020: 1.79 ± 0.8, $p = 0.32$). However, the number of dropouts significantly decreased in the telemedicine group (1% vs. 9% in the control group, $p = 0.025$).

The satisfaction survey was answered by 59 (77%) patients or their parent/guardian in case they were underaged (Table 2). All the respondents affirmed that their doubts were solved through telemedicine and 95% of the patients expressed that they found

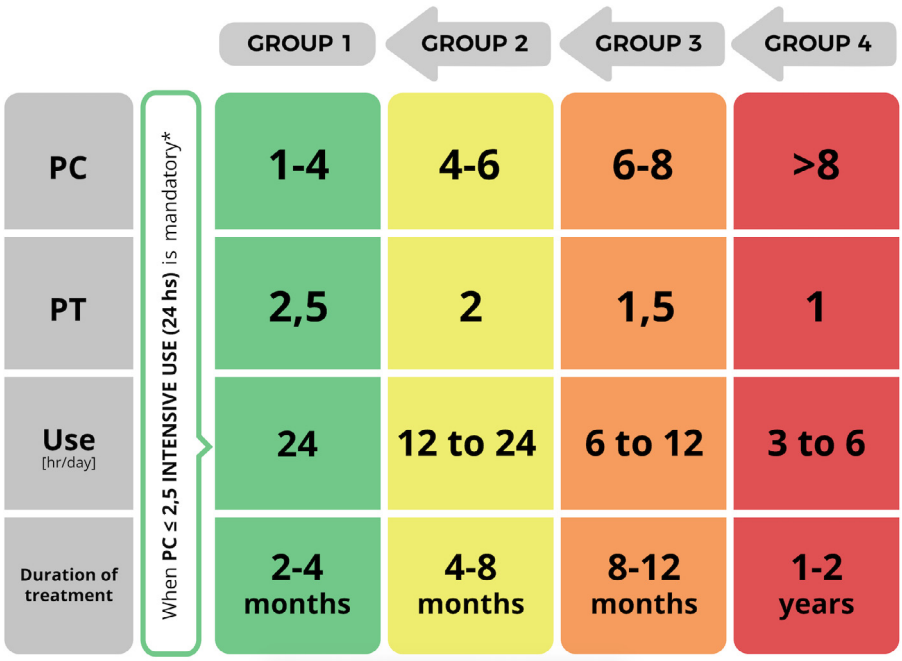

Fig. 1. Treatment protocol of pectus carinatum patients. PC: pressure of correction (pressure measured before adjustments to the dynamic compressor system are made.) PT: pressure of treatment (pressure applied on the chest after adjusting the dynamic compressor system).

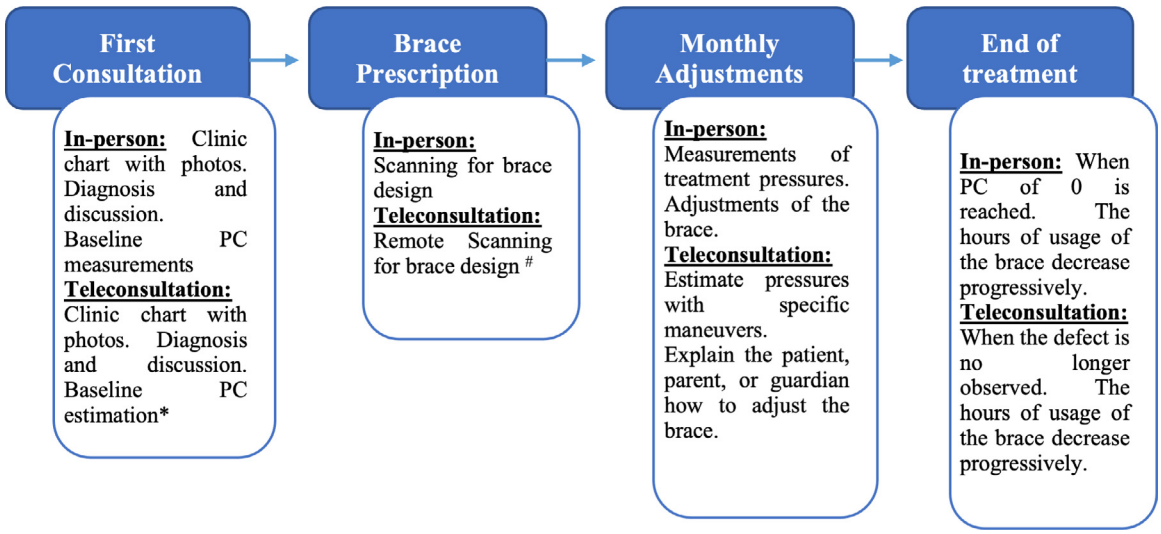

Fig. 2. Workflow of the encounters with the pectus carinatum patients. In-person and with teleconsultations. PC: Pressure of Correction. *: Due to the flexibility of stiffness of the chest and the age a PC can be estimated with a few compressions. #: Made by taking multiple photos of all the chest circumference.

telemedicine comfortable. Of note, those with a lower income evidenced the highest intention of continuing with telemedicine (low 84%, mid 61%, high 50%).

8. Discussion

This study aimed to report the feasibility of telemedicine for diagnosing and treating pectus carinatum with a dynamic compressor system during the COVID-19 lockdown.

As defined by Bashshur: *Telemedicine consists of an integrated system of healthcare delivery that employs telecommunications and computer technology as a substitute for face-to-face contact between patient and doctor* [8]. Although a useful, promising tool, telemedicine was not formally and globally implemented in the healthcare system until the sudden spread of COVID-19 led to global lockdown without further ado.

Although there are not published reports on pectus patients and telemedicine, Wood et.al. [9] reported a success rate of 92.2% in making diagnosis and treatment plans using telemedicine for preoperative management of patients undergoing general anesthesia for oral and maxillofacial surgery and Segura-Sanpedro et.al. [10] used telemedicine in 24 patients for post-appendectomy wound follow-up showing rates of satisfaction of 94%. Also, Metzger et.al. [4] surveyed 123 patients or caregivers that used telemedicine for a pediatric surgical appointment demonstrating a satisfaction rate of 86%.

By means of quick implementation of telemedicine (telepectus), one month after isolation began, we were able to reset and even sustain the same volume of pectus carinatum consultations as the previous, non-pandemic year. Even more, we were able to reach out to new patients, maintain treatment, and complete it remotely in 16 cases.

Fig. 3. Teleconsultation: The physician shows the patient where and how to modify the dynamic compressor system to advance in the treatment. Thin arrow: dynamic compressor system. Dotted arrow: previous photos of the patient. Thick arrow: medical records of the patient.

Table 2
Questions and answers of the satisfaction survey. 59 respondents.

Questions	Answers (number / percentage)	
Type of Health Insurance	Private Practice	9 / 15.2%
	Social insurance	27 / 45.7%
	No insurance	23 / 39%
Income	Low	19 / 32%
	Mid	36 / 61%
	High	4 / 7%
Type of Internet connection	Wifi	53 / 90%
	Optic Fiber	2 / 3%
	4G	4 / 7%
Were there any problems with the connection?	Yes	4 / 7%
	No	53 / 90%
	Sometimes	2 / 3%
Did you feel comfortable having a consultation through a screen?	Yes	56 / 95%
	No	3 / 5%
Did you feel that every doubt was solved?	Yes	59 / 100%
	No	0
How difficult was it to follow the instructions for the compressor/Vacuum bell modification? (Scale 1- Very Easy to 5 - Very difficult)	1.77 ± 0.8	
How difficult was it to modify the compressor/Vacuum bell modification? (Scale 1- Very Easy to 5 - Very difficult)	1.77 ± 1.1	
After COVID 19 Pandemic is solved. Would you continue with telemedicine?	Yes	40 / 67.8%
	No	8 / 13.5%
	Prefers in-hospital consultation	11 / 18.7%

The number of withdrawals decreased significantly in the study group compared to controls.

We hypothesized that the widespread use of mobile devices with camera and the increase in internet connection access allowed in-house teleconsultations, thus avoiding the need to travel and lose work and school days. In addition, we think that confinement favored the use of the dynamic compressor system given that patients were not required to take the device to school or work.

Of note, patients from both, the public and the private hospitals, were able to do teleconsultations with mobile devices from their homes.

The implementation of a videoconference platform to connect with patients was straight forward to implement. Providing an explanatory brochure and ensuring that patients understood how the platform worked during the first consultation might have helped. In addition, the fast spread use of this platform in other situations such as school or work might have collaborated as well.

The satisfaction survey revealed that patients had no significant problems in understanding the instructions for the compressor's adjustments. Thus, we were able to advance with treatments in the same way we did during in-person consultations. Although many of our patients were happy with teleconsultations, we think that some of them prefer in-hospital visits, and to meet the doctor.

Our experience supports publications that affirm that the use of telemedicine is effective for the treatment and remote follow-up of patients [2,11,12].

Although telepectus started as a response to lockdown due to the COVID-19 pandemic, we are optimistic that this tool might endure after that, allowing physicians to follow-up patients that live in isolated or distant communities. This experience has changed our perspective on the follow-up of pectus carinatum patients who live far from our centers. Now we use a mixed approach with them (i.e., in-person and telemedicine).

This study has some limitations. Our study population resides in a large metropolitan area. Although we included patients from a private and public health center, patients from other geographic regions might respond differently to telepectus. Given that only 70% of the patients included in the telepectus program responded the survey, we ignore the degree of satisfaction of non-respondants. Future directions may include the analysis of a combination of virtual and 1 or 2 in-person encounters specially during the follow-up period.

9. Conclusions

This study demonstrated the feasibility of remote care of patients with pectus carinatum using the dynamic compressor system through telemedicine during the COVID-19 lockdown. Treatment adherence was better with telemedicine than in-house medical care during a comparable, non-pandemic period. From the group of patients who answered the survey (77%), the majority revealed a high satisfaction rate with telemedicine for the non-operative treatment of pectus carinatum, irrespective of their reference center (public or private).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jpedsurg.2021.10.048.

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