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Research Paper

Surgical Treatment of Palestinian Patients With Congenital Heart Disease in a Medical Center in Israel: Challenges and Outcome

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ABSTRACT

Background: The treatment of congenital heart disease patients in the West Bank and Gaza involves both medical and political challenges. Understanding the difficulties faced in treating the Palestinian population is an important step to improving surgical care, better allocating resources and overcoming the region's unique problems.
Methods: The Hadassah Medical Center congenital heart disease database over the 2011–2017 period was analyzed. There were 872 operations performed in patients with Israeli health insurance and 207 operations in Palestinian patients. Patient characteristics and surgical outcome were compared between the two groups using standard statistical practices.
Findings: The Society of Thoracic Surgeons Complexity Scores were significantly higher in the Palestinian patients, $p = 0.003$ ($d = 0.27$, 95% CI, 0.12 to 0.42). Israeli neonates had surgery at an average age of 9.5 ± 7.8 days as compared to Palestinian neonates with an average age of 15.7 ± 8.2 days, $p < 0.001$ ($d = 0.78$, 95% CI, 0.41 to 1.15), a finding indicative of a possible delay of treatment. Overall in hospital mortality was not significantly different. Late mortality was significantly higher for the Palestinian 5.4% (9/168) compared to Israeli patients 2% (14/698), $p = 0.015$ (RR = 2.67, 95% CI, 1.18 to 6.07).
Interpretation: The findings suggest that Palestinian patients receive later treatment and poorer follow-up care than Israeli patients. Despite the political challenges in the region surgical results are excellent and comparable between the two groups. The challenges described are not unique to congenital heart disease and may affect many medical fields. We believe that extensive collaborations between Israeli and Palestinian physicians may be key to improving the Palestinian medical care.
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1. Introduction

Over the last decade significant advances have been made in the treatment of congenital heart disease in the western world [1]. Prenatal care, neonatal repair of complex congenital heart defects, advances in postoperative care and continued follow-up into adulthood have contributed to the significant decrease in morbidity and mortality. Unfortunately, treatment of congenital heart disease is a highly specialized and expensive medical specialty [2]. In less privileged regions of the world high costs make congenital heart surgery unattainable for most patients. Furthermore, late diagnosis, associated comorbidities, limited infrastructure and limited resources contribute to the suboptimal outcomes of those who do undergo surgery [3].

Currently, the Palestinian health care system lacks the economic resources and sophisticated infrastructure needed to treat many of the patients with congenital heart disease living in the West Bank and Gaza [4], and as a result many of these patients are treated in medical centers in Israel. This has created a unique situation where for many years patients from a less privileged region have been treated in a developed country's medical system. The data collected over the years can be used to compare the outcomes and quality of care of the two distinct populations. The objective of this study was to compare patient characteristics and surgical outcomes of patients from the West Bank and patients from Israel treated at Hadassah Medical Center in Jerusalem. This study's results may further our understanding of the differences between these two patient populations with the hope of improving their surgical care.

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Research in context

Evidence before this study

Demographic characteristics, health status, and health services of the Palestinian population living in the West Bank and Gaza have been described in several studies in recent years, mainly in context with the regional prolonged conflict between Israel and the Palestinians. Some studies address child and maternity health which was found to be comparable to the neighboring countries. Other studies have shown that acquired heart disease, cerebrovascular disease, and cancer as the major causes of morbidity and mortality similar to the western world.

Our literature search included the available data in the last 10 years. We found very little information about Palestinian patients' surgical treatment of congenital heart disease. Most of this data is anecdotal without systematic collection, analysis of data, and outcome.

Added value of this study

This study represents a systematic effort to analyze the unique problems associated with surgical treatment of Palestinian patients with congenital heart disease. The comparison to Israeli patients has emphasized the differences in surgical complexity and outcomes between the two populations. Furthermore, it has shown the unique problems of an ongoing regional conflict on the time interval between diagnosis and surgical treatment. We have shown the potential treatment options by various organizations and the advantages and disadvantage of each treatment option in regard to patient care and its influence on the development of the Palestinian health care.

Implications of all the available evidence

Surgical outcome of Palestinian patients treated for congenital heart disease in Israel is comparable to the outcome of Israeli patients. The evidence of our study has encouraged us to improve our communication and cooperation with the Palestinian cardiologists in order to shorten the time interval to diagnosis and surgical treatment, in addition to improvement of long term follow-up to reduce the long-term mortality.

2. Methods

2.1. Study Design and Population

We reviewed the records of all patients with congenital heart defects who underwent heart surgery at the Hadassah Medical Center in Jerusalem between January 2011 and December 2017. There were 872 operations in patients with Israeli health insurance and 207 operations in Palestinian patients. Patient data was collected in accordance with the principals of the Society of Thoracic Surgeons' (STS) database [5]. Our database, established in January 2011, records information about patient demographics, medical diagnoses, surgical complexity scores, postoperative course including ICU stay, ventilation time, complications, hospital stay, clinical and echocardiographic outcome, and postoperative clinic follow-up. This data is reported quarterly to the Society of Thoracic Surgeons as part of our participation in the STS database.

The cost of treatment for Israeli patients was covered by the Israeli national health insurance. This coverage is identical for all ethnic groups: Jewish Israelis, Arab Israelis and the majority of Arabs living in East Jerusalem. The cost of treatment for Palestinian patients was covered by donations, mainly by the French grant 'A Heart for Peace' or by the Palestinian Authority. Due to the difficult economic situations in the West Bank and Gaza, Hadassah Medical Center charges these organizations half the cost it charges for Israeli patients. Hadassah Medical Center charges the same price for all types of heart surgeries for all patients, regardless of complexity or hospital length of stay. The cost of treatment did not affect the type of treatment offered to either group of patients.

All the patients were evaluated by our pediatric heart institute team in addition to the referring cardiologists before the optimal treatment plan was presented to every patient's family. After discharge from the hospital the Palestinian patients were followed by their referring pediatric cardiologist in the West Bank. The Hadassah Medical Center Institutional Review Board approved the study and waived individual patient consent due to the retrospective nature of the study.

2.2. Variables

The primary endpoints of the study were surgical mortality and five-year survival from hospital discharge. Surgical mortality was defined as mortality during the index hospitalization. Mortality status post discharge from the hospital was obtained from the Palestinian Central Bureau of Statistics and the Israeli Population and Immigration Authority. Secondary endpoints included time to surgical treatment as well as pediatric intensive care unit (PICU) and hospital length of stay (all measured in days).

The main study exposure was the patients' nationalities. Patient characteristics that were accounted for included age, sex, STS complexity scores and single ventricle vs biventricular surgical repair.

Not all Palestinian patients are referred for treatment in Israel and the referral process may create a selection bias in the Palestinian patient population. We believe the main deciding factor is financial and therefore more complex patients are referred for treatment in Israel. Additionally, the rates of induced termination of pregnancy due to congenital heart disease may differ between the Arab and Non-Arab populations potentially contributing to a selection bias. Potential confounding variables may include differences in maternal follow-up during pregnancy, socio-economic status, ethnic origin, presurgical medical surveillance, and time from diagnosis to treatment. Length of gestation and birth weights may also differ between the populations and might confound mortality rates in neonates. According to our data, 95% of Israeli patients had a routine long-term pediatric cardiology follow-up post-surgery as opposed to only about 70% of the Palestinian patients. This disparity may affect long term survival.

The Society of Thoracic Surgeon's Surgical Complexity Stratification is a method of analysis in which the data are divided into relatively homogeneous groups (strata). The data is analyzed and reported within each stratum. The STS method uses 5 categories and serves as the main complexity adjustment tool for the STS Congenital Heart Surgery Database. Each procedure received a score ranging from 0.1 to 5.0, based on the estimated mortality. The procedures were then distributed by the growing risk and grouped into the 5 categories.

The Mortality Categories are an empirically derived methodology of complexity stratification based on statistical estimation of the risk of mortality from an analysis of objective data from the STS Congenital Heart Surgery Database and the European Congenital Heart Surgery Database [6].

2.3. Data Analysis

The association of the patients' nationalities with surgical complexity stratification and mortality was first studied by univariate analysis. Chi-squared test or Fisher's exact test were used to compare categorical variables and Relative Risk (RR) was used to assess the effect size. Comparison of quantitative and ordinal variables between two independent

Table 1
Demographic and clinical characteristics by patient's nationality.

Characteristics	Israeli pt (n = 872)	Palestinian pt (n = 207)	p value
Sex			
Female	47.4% (413)	41.1% (85)	0.1
Male	52.6% (459)	58.9% (122)	
Age range			
Less than 4 weeks	22.9% (200)	16.9% (35)	0.158
4 weeks to one year	36.4% (317)	34.8% (72)	
One year to 18 years	35% (305)	41.5% (86)	
More than 18 years	5.7% (50)	6.8% (14)	
STS complexity			
1	35.1% (306)	21.7% (45)	<0.001
2	33% (288)	35.7% (74)	
3	11.2% (98)	14% (29)	
4	16.9% (147)	24.6% (51)	
5	3.8% (33)	3.9% (8)	
Anatomy			
Single ventricle	19.8% (172)	25.6% (53)	0.067
Biventricular	80.2% (700)	74.4% (154)	

Abbreviations: STS, Society of Thoracic Surgeons; pt, patient.

groups was made using the Student's t test or the Mann–Whitney U test as appropriate and standardized mean difference (a.k.a. Cohen's d) was used to assess the effect size.

As discussed above, selectivity bias is manifested in an uneven distribution of the complexity score among Israeli and Palestinian patients. We studied surgical mortality in a binary outcome regression setting by the logistic model, which controls for the confounding effect of complexity scores; adjusted odds ratio was used to assess the effect size. The co-variates included in this regression analysis were sex, STS complexity, nationality and the natural logarithm of age (covariates which were not statistically significant were eventually excluded from the regression model). The dependent variable was surgical mortality.

Five-year survival was first analyzed by a Kaplan–Meier estimator of the survival function. This analysis did not include the cases of surgical mortality; for patients who underwent multiple surgeries follow up time was calculated from the first surgery. Survival spans of recent patients with follow-up times shorter than 5 years were right-censored at the follow-up time available. On the other end, survival spans of earlier patients, with follow-up period longer than 5 years, were limited to 5 years. The total number of patients included in the Kaplan–Meier estimator was 694 Israelis and 169 Palestinians. Then, a proportional hazards Cox model was estimated to adjust for possible confounding effects on long term survival. Hazard ratios were used to assess the effect size. The Cox model regression included the same co-variates as the logistic regression model of surgical survival, with an addition of the natural log of PICU hospitalization length which we used to account for recovery time and post-surgical complications.

22 Israeli patients and 5 Palestinian patients were excluded from the total hospitalization length analysis due to missing data. Similarly, 32 Israeli patients and 8 Palestinian patients were excluded due to missing data on their PICU hospitalization length. We assume that this data was missing at random and therefore does not create a selection bias. Statistical analysis was performed using SPSS 21. A p value of less than 0.05 was considered statistically significant.

3. Results

Demographics and clinical characteristics of the patient population are presented in Table 1. The mean STS complexity scores were significantly higher in the Palestinian patient population, $p < 0.001$. As aforementioned, the patient's nationality supposedly confounds for a variety of factors, including socio-economic status, ethnic and cultural differences, and pre- and post-surgery medical attention, to mention the prominent ones. To determine the importance of some of these factors, we further divided the Israeli patients by ethnic origin into Israeli Non-Arab (524 patients) and Israeli Arab (348 patients), to be compared with the Palestinians (207 patients). The Israeli Arab population is ethnically and culturally similar to the Palestinian population.

The distribution of STS complexity scores for the three population groups is presented in Fig. 1. Mean complexity score of the Palestinian patient population was significantly higher than the means of Non-Arab and Arab Israeli patient populations ($p < 0.001$ and $p = 0.006$ respectively). Notably, the difference between mean values of the complexity score of Non-Arab and Arab Israeli populations was not statistically significant ($p = 0.32$).

A comparison of the average complexity score in patients with single ventricle anatomy did not show any significant difference between the Israeli and Palestinian patient populations, $p = 0.74$. However, there was a higher percentage of patients with single ventricle anatomy treated in the Palestinian group although the difference didn't reach statistical significance ($p = 0.067$, see Table 1).

Mortality rates are presented in Table 2. Overall surgical mortality was 2.2% for the Israeli patients and 3.9% for the Palestinian patients, $p = 0.163$ (RR = 1.77, 95% CI, 0.79 to 4.0). Surgical mortality within the population of single ventricle patients was 4.6% for the Israeli patients compared to 11.3% for the Palestinian patients, $p = 0.077$ (RR = 2.45, 95% CI, 0.89 to 6.74). In the population of patients with biventricular repair, the surgical mortality was 1.6% for the Israeli patients compared to 1.3% for the Palestinian patients, $p = 0.8$ (RR = 0.83, 95% CI, 0.19 to 3.68). A binary outcome logistic regression model, that assessed surgical

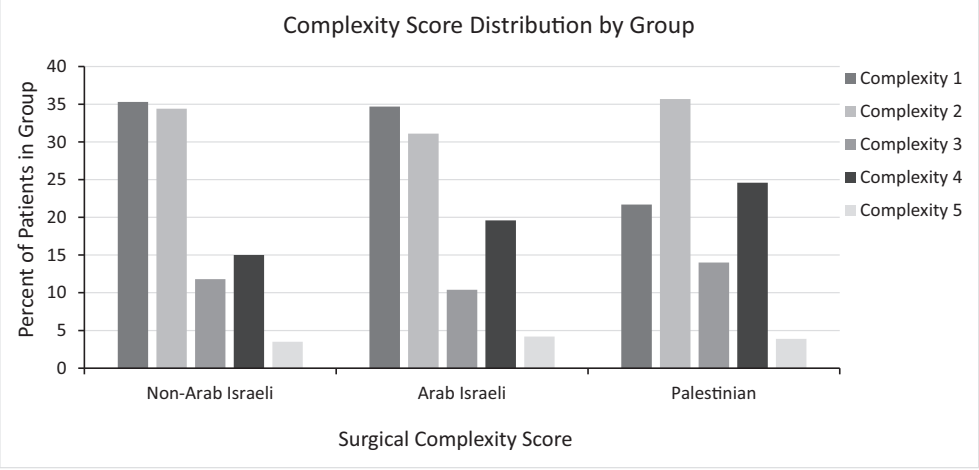


Fig. 1. Histogram comparing the Society of Thoracic Surgeons' complexity score distribution by patient group.

Table 2
Mortality rates by patient's nationality.

	Mortality		p value	Relative Risk (95% CI)
	Israeli pt	Palestinian pt		
Total surgical mortality	2.2% (19/872)	3.8% (8/207)	0.163	1.77 (0.79 to 4.0)
Single ventricle surgical mortality	4.6% (8/173)	11.3% (6/53)	0.077	2.45 (0.89 to 6.74)
Biventricular surgical mortality	1.6% (11/699)	1.3% (2/154)	0.8	0.83 (0.19 to 3.68)
Mortality post-release	2% (14/694)	4.7% (8/169)	0.055	2.28 (0.97 to 5.36)

Abbreviations: CI, confidence interval; pt, patient.

mortality while controlling for the STS complexity disparity, yielded p = 0.346 (adjusted OR = 1.52, 95% CI, 0.64 to 3.63) between the Palestinian and Israeli patient populations. The adjusted odds ratios of the predictors in the surgical mortality model are presented in Table 3.

Mean PICU and hospital length of stay are presented in Table 4. PICU length of stay and hospital length of stay showed no significant differences. Mean PICU length of stay was 6.29 (SD 10.8) days for the Israeli patients and 5.6 (SD 7.7) days for the Palestinian patients, p = 0.65 (Cohen's d = −0.06, 95% CI, −0.22 to 0.092). Mean hospital length of stay was 11.1 (SD 11.4) days for the Israeli patients and 11.4 (SD 10.5) days for the Palestinian patients, p = 0.7 (Cohen's d = 0.028, 95% CI, −0.13 to 0.18).

Identifying a possible delay in diagnosis or treatment between the two populations was difficult since we lacked the date of diagnosis for each patient. We used the neonatal (patients younger than 4 weeks) patient population's age during first surgery as a potential marker for delay of treatment in Palestinians. Israeli neonates underwent surgery significantly earlier, at an average age of 9.5 (SD 7.8) days while Palestinian neonates underwent surgery at an average age of 15.7 (SD 8.2) days, p < 0.001 (Cohen's d = 0.78, 95% CI, 0.41 to 1.15, see Table 4).

Kaplan–Meier estimates of 5-year survival function are presented in Fig. 2. Five-year post-release mortality was higher among the Palestinian patients (4.7%, 8/169) than the Israeli patients (2%, 14/694) but the difference did not reach statistical significance, p = 0.055 (RR = 2.28, 95% CI, 0.97 to 5.36). The estimates of the proportional hazards Cox model, accounting for potential confounding effect of the surgery complexity are shown in Table 5. In line with the Kaplan–Meier estimates, the Cox model showed a higher late mortality among Palestinian patients, but did not reach statistical significance either, p = 0.062 (HR = 2.52, 95% CI, 0.95 to 6.66).

4. Discussion

The incidence of congenital heart disease at birth ranges from eight to 12 per 1000 live births. The burden of congenital heart disease has been greater in regions with high fertility rate and low income [7]. Both the West Bank and Gaza suffer from a high unemployment rate, creating economic challenges for most of their populations.

The prolonged Palestinian–Israeli conflict has had significant deleterious effects on the Palestinian medical care [8]. As a result of the unstable situation, Palestinian health care has been provided by several different entities: The Palestinian Authority health care system, the UN Relief and Work Agency and the private medical sector. Current health services, specifically tertiary health care providers, are limited and unable to satisfy the needs of the large West Bank and Gaza populations [9]. This situation has forced the Palestinian Authority to refer patients with complex health conditions for treatment in Israel, Egypt and Jordan.

The Israeli health care system has been heavily involved, for many years, in the treatment of Palestinian patients and training of Palestinian physicians in Israeli hospitals [10,11]. This involvement has continued despite significant fluctuations in the relationship between the Palestinian and Israeli governments. Both sides believe that this medical cooperation may serve as a bridge for rebuilding trust in the future [12].

The current medical team in the West Bank and Gaza providing treatment for patients with congenital heart disease includes several perinatology physicians and pediatric cardiologists. About a third of these physicians were trained in Israeli medical centers. Yet prenatal care is still very limited in the West Bank and Gaza compared to Israel.

There are two medical centers in the West Bank that perform congenital heart surgery. The larger of the two is Al Makassed Islamic Charitable Society Hospital in east Jerusalem, operating since 2013 with a pediatric cardiothoracic department and a Palestinian medical team. The second center is located in the city of Ramallah and until recently was operated mainly by international medical mission teams. Previous data has shown that the work performed by such teams appears to be beneficial only when no other option is available. Worse results and a lack of cost-effectiveness compared to other platforms have curtailed their role [13]. In addition, some surgical mission trips have been used as an educational opportunity for the visiting staff rather than an opportunity to advance local medical treatment [14]. In order to alleviate these problems the American Academy of Pediatrics has published guidelines for short surgical mission trips [15]. Long term success of these visits can be achieved only when linked to a training program of local surgeons and support staff which will enable them to develop a local, independently functioning, surgical center. We believe that, of the currently available options for pediatric congenital heart surgery

Table 3
Estimates of logistic regression for binary outcome model of surgical mortality.

	No. of survivors	No. of non-survivors	Adjusted OR (95% CI)	p value
Nationality				
Israeli	853/872 (97.8%)	19/872 (2.2%)	1.0 [ref.]	
Palestinian	199/207 (96.1%)	8/207 (3.9%)	1.52 (0.64 to 3.63)	0.346
STS complexity score				
1	349/351 (99.4%)	2/351 (0.6%)	1.0 [ref.]	
2	360/362 (99.4%)	2/362 (0.6%)	0.94 (0.13 to 6.69)	0.946
3	123/127 (96.9%)	4/127 (3.1%)	5.42 (0.98 to 30.05)	0.053
4	186/198 (93.9%)	12/198 (6.1%)	10.61 (2.34 to 48.22)	0.002
5	34/41 (82.9%)	7/41 (17.1%)	34.99 (6.98 to 175.42)	<0.001
Constant			0.005	<0.001

Abbreviations: OR, odds ratio; CI, confidence interval; STS, Society of Thoracic Surgeons.
Notes: The model also included patient's sex and natural logarithm of age (days) at surgery – omitted because of low statistical significance. The Hosmer and Lemeshow test for goodness of fit yielded p = 0.87.

Table 4
Hospitalization length and neonate age by patient's nationality.

	Israeli pt	Palestinian pt	p value	Cohen's d (95% CI)
Mean hospital stay (days)	11.1 (SD 11.4)	11.4 (SD 10.5)	0.7	0.028 (−0.13 to 0.18)
Mean PICU stay (days)	6.29 (SD 10.8)	5.6 (SD 7.7)	0.65	−0.06 (−0.22 to 0.09)
Mean age of neonates at first surgery (days)	9.5 (SD 7.8)	15.7 (SD 8.2)	<0.001	0.78 (0.41 to 1.15)

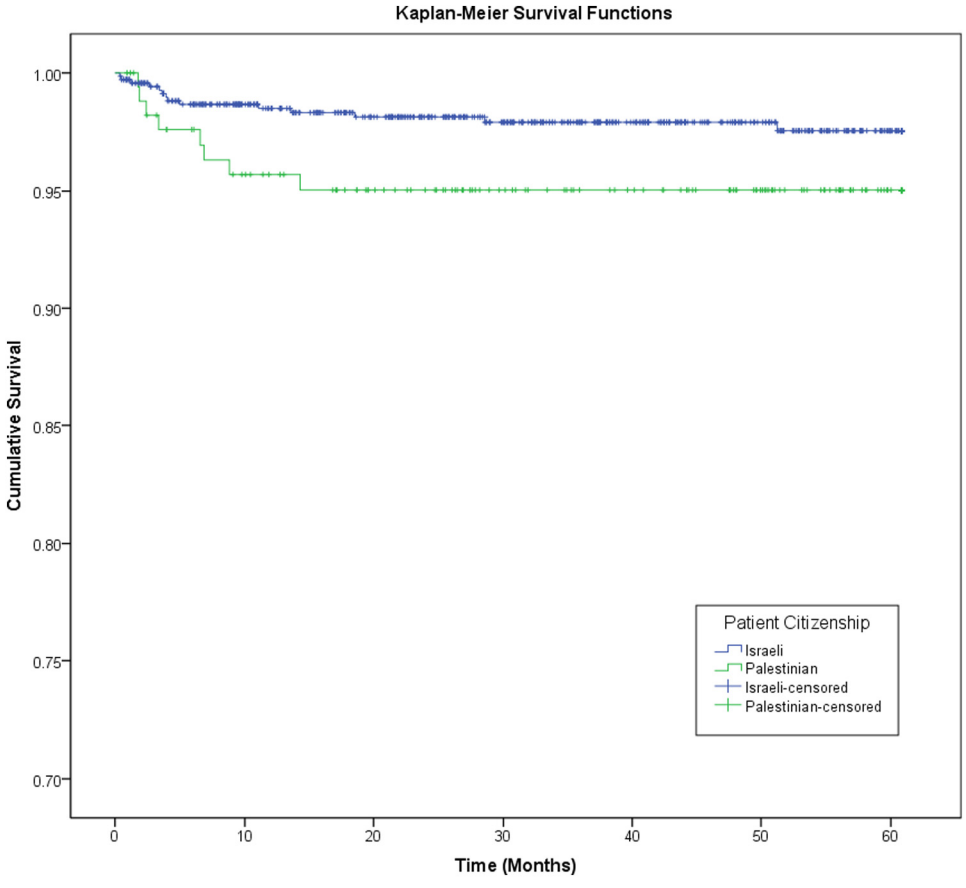
Abbreviations: PICU, pediatric intensive care unit; SD, standard deviation; CI, confidence interval.

in the West Bank and Gaza, short surgical mission trips present the worst quality of care for Palestinian patients.

One of the quality measures for congenital and pediatric cardiac surgery is participation in a national or international database [16]. This has been shown to improve patient care in low income regions as well [17]. Participation is usually limited to the developed world due to the financial resources needed to participate in such a database. Furthermore, health research in the West Bank and Gaza is poorly prioritized and does not focus on the diseases prevalent in the region [18].

In recent years the World Society for Pediatric and Congenital Heart Surgery has started an international database for the improvement of care across the world [19]. However, in low income regions every financial resource available is used for direct patient care. Until joining the database will be free of charge for low income regions it will be impossible to achieve significant participation. The Palestinian medical system has proven its willingness to create registries to improve care but lacks the funding to do so [20].

Utilizing our patient data, we were able to identify several statistically significant differences between Palestinian and Israeli patient populations, many of which result from the complex situation in the region. The significantly higher surgical complexity scores of congenital heart disease among the Palestinian patients and the increased number of patients with a single ventricle anatomy treated at our institution compared to the Israeli patients may be the result of several factors. Our findings indicate that the disparity in the complexity score is associated with the Palestinian nationality rather than Arab ethnicity. By extension, this supports our assessment that the limited resources and infrastructure have led the Palestinian health care system to treat most of their patients with lower surgical complexity scores within their own system either through medical mission groups or at Al Makassed Islamic Hospital in east Jerusalem. Some of the more complex patients are therefore referred to medical centers in Israel for treatment. Additionally, the high consanguinity rate among Palestinians (about 40%) has been known to contribute to the increased prevalence of complex birth



Number at risk						
Months	0	12	24	36	48	60
Israeli	694	573	475	376	290	184
Palestinian	169	147	130	102	86	46

Fig. 2. Post discharge Kaplan–Meier survival analysis stratified by nationality. Censored patients are indicated on the curves. Time axis is right censored at 60 months.

Table 5
Multivariate Cox regression model of 5-year post discharge mortality in Israeli and Palestinian patients.

	No. of survivors	No. of non-survivors	Hazard ratio (95% CI)	p value
Nationality				
Israeli	680/694 (98%)	14/694 (2%)	1.0 [ref.]	
Palestinian	161/169 (95.3)	8/169 (4.7%)	2.52 (0.95 to 6.66)	0.062
STS complexity score				
1	302/304 (99.3%)	2/304 (0.7%)	1.0 [ref.]	
2	280/282 (99.3%)	2/282 (0.7%)	1.05 (0.15 to 7.63)	0.959
3	103/106 (97.2%)	3/106 (2.8%)	5.59 (0.88 to 35.71)	0.069
4	134/145 (92.4%)	11/145 (7.6%)	9.06 (1.72 to 47.8)	0.009
5	22/26 (84.6%)	4/26 (15.4%)	31.67 (4.27 to 234.73)	0.001
PICU hospitalization length (days)[a]	5.0 (SD 7.5)[b]	23.9 (SD 29.8)[b]	1.04 (1.02 to 1.05)	<0.001
Age at surgery (days)[a]	1751 (SD 3370)[b]	1011 (SD 1867)[b]	1.25 (1.01 to 1.56)	0.041

Abbreviations: HR, hazard ratio; CI, confidence interval; STS, Society of Thoracic Surgeons; PICU, pediatric intensive care unit; SD, standard deviation.
Notes: The model also included patient's sex and hospital stay – omitted because of low statistical significance.
[a] Natural log of continuous variables was used in the regression.
[b] Mean and standard deviation reported for continuous variables.

defects [21,22]. Since no statistically significant difference was detected in the complexity of Arab Israeli and Non-Arab populations, we conclude that ethnic differences (both cultural and genetic) likely aren't a major contributor to the difference in complexity.

Congenital heart surgery in less privileged regions of the world has been linked to delay of care [3]. Ascertaining if there is a delay in treatment of Palestinian patients has proven challenging, mainly since we don't have the exact date of diagnosis for the entire patient cohort.

We overcame this difficulty by assessing the neonatal patient population's age during surgery as a marker for delay of treatment. Our findings showed a significant time delay in Palestinian surgical treatment as the Palestinian neonates underwent surgery almost a week older on average than Israeli neonates. This difference may be due to the very limited prenatal diagnosis in the West Bank or because of a shortage of pediatric cardiologist availability, both of which may cause a delay in diagnosis. Additional factors which may contribute to a delay of treatment include the lengthy process of arranging transport to an appropriate surgical center in Israel, the lack of availability of ICU beds or the logistics of obtaining travel permits.

Since similar conditions are shared by all patients of the Palestinian healthcare system, we may extrapolate that these factors may causes a delay in treating older patients as well.

Given our results showing that the Palestinian patients had a significantly higher surgical complexity score and arrived for surgery with a significant time delay, we expected their outcome to be significantly worse than that of the Israeli patients. However, the Palestinian patients' overall mortality was not significantly different than that of the Israeli patients. In the single ventricle physiology subgroup of patients, the mortality of the Palestinian group was higher than the mortality of the Israeli group, yet this difference did not reach statistical significance ($p = 0.067$). Additional data may be needed to substantiate the robustness of this finding. Further analysis may be necessary to assess the difference in this subgroup. Surprisingly, there was no significant difference in the ICU or hospital length of stay between the two groups.

During this study we found that late mortality was higher for Palestinian patients than for Israeli patients. This finding was not found to be statistically significant in the regression analysis that controlled for surgical complexity, age and PICU stay. The higher late mortality may be associated with the lower percentage of routine long-term pediatric cardiology follow-up among the Palestinian patients. Presumably the lower follow-up rate is another problem caused by the limited resources in the West Bank and Gaza.

In light of these findings we added a Palestinian pediatric cardiologist to our team which has enabled us to create outreach clinics in the West Bank to shorten referral times for surgical treatment. He has also established a postoperative follow-up clinic for Palestinian patients, while we work to provide a better long-term follow-up solution for Palestinian patients with single ventricle anatomy and high surgical complexity scores. Recently, a Palestinian surgeon trained at our department has begun a small pediatric surgical program in Ramallah supported by surgical mission groups and our hospital.

Some of the limitations of this study include the lack of data on potential confounders such as prenatal care and induced abortion rates due to congenital heart disease, which likely differ between the populations. Additionally, we lacked the data to accurately estimate the time delay between diagnosis and treatment of non-neonatal patients, which may influence surgical outcomes. The number of patients included in this study may be too small to capture some clinically relevant associations due to lack of statistical power.

This study has illustrated several problems the Palestinian medical system is facing with treatment of pediatric and congenital heart surgery. The challenges described are not unique to congenital heart disease and may affect many other medical fields in the Palestinian medical system. Some people believe that these problems are all the result of the ongoing political conflict in the region [23,24]. While the conflict may indeed be a major factor, we as physicians have very little influence on the political situation. It is our duty to find any way possible to cooperate and improve the care the Palestinian patients receive even under the current circumstances.

This study has helped us better understand the challenges specific to surgical treatment of Palestinian patients with congenital heart disease. As a result of our findings we have strengthened our collaboration with the pediatric cardiologists in both the West Bank and Gaza in order to shorten referral times and are working to provide a better long term follow up solution for Palestinian patients with single ventricle anatomy and high surgical complexity score.

Authors' Contributions

EE: Literature search, study design, wrote the manuscript

EE: Statistical work, data analysis and interpretation, editing, figures
JG: Data collection, manuscript revision, study design
IM: Data collection, follow-up
OMS: Manuscript revision
BM: Data collection from Palestinian central bureau of statistics.

Declaration of Interests

We declare no competing interests.

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