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Original Article

Fast track radical surgery in pediatric patients with congenital heart diseases

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Abstract: Objective: The goal of this study was to analyze the effect of fast track radical surgery (FTS) in pediatric patients with congenital heart diseases (CHDs). Methods: A total of 99 pediatric patients with CHD was prospectively analyzed and divided into two groups according to the random number table method. Of those, 49 patients were enrolled in the regular treatment group, and 50 who received FTS, including limited fluid intake, early extubation, and pain control, were enrolled in the fast track group. Apart from regular treatment procedures, fluid infusion limitation, early extubation, and pain control were included in FTS. Pulmonary arterial pressure (PAP) was evaluated before and after surgery and the early extubation rate, reintubation rate, mechanical ventilation time, treatment time in the intensive care unit (ICU), hospitalization time, and the incidences of pulmonary complications were recorded. The quality of life before surgery and within 3 months postoperatively using the Short Form 36 questionnaire was also assessed. Results: A decrease was identified in the postoperative PAP in both groups ($P < 0.05$), and a decrease in the fast track group was more compared to that in the regular treatment group ($P < 0.05$). Moreover, the early extubation rate was significantly lower in the regular treatment group than that in the fast track group ($P < 0.05$). The durations of ICU stay, hospitalization time, and the incidences of pulmonary complications were also longer or higher in the regular treatment group those in the fast track group respectively ($P < 0.05$). The differences of preoperative quality of life showed no statistical significance ($P > 0.05$). At 3 months after treatment, all indicators of quality of life were increased to varying degrees ($P < 0.05$), and scores in the fast track group was more than those in the regular treatment group ($P < 0.05$). There was no significant difference in pulmonary arterial pressure between the two groups before operation ($P > 0.05$). The pulmonary arterial pressure of the two groups decreased after operation ($P < 0.05$) and the pulmonary arterial pressure in the fast track group was significantly lower than that in the regular treatment group ($P < 0.05$). Conclusion: For pediatric CHD patients, FTS increased the early extubation rate and shortened the ventilation time, duration of ICU stay, and hospitalization time, with associated decreases in the incidence of pulmonary complications.

Keywords: Fast track surgery, congenital heart disease, radical surgery, quality of life

Introduction

Congenital heart disease (CHD) is a common disease caused by anomalous development of the fetal cardiovascular system and abnormal degeneration of tissues [1, 2]. The reported incidence rate of CHD is 3% [3]. With advances in surgical and interventional techniques, CHD patients have experienced significant improvement in prognosis, but optimization of treatment needs further research, especially with respect to perioperative management [4].

Fast tract surgery (FTS), first introduced in the 1990s, is used as a perioperative management strategy [5]. FTS can improve efficacy and reduce the incidence of complications, promote faster recovery, shorten the hospitalization time and lower medical costs [5, 6]. Considering the diverse CHD subtypes and the complexity of surgical treatment, FTS is necessary for the majority of the patients [7]. For performing FTS, the physicians must be completely aware of the pathophysiological processes in CHD to optimize surgical and anesthetic techniques and improve pain management, thereby, effectively improving perioperative management [7, 8]. However, application of FTS requires more in-depth research, despite its recent use in radical surgery for CHD patients, because its application in the basic-level hospitals is low. Most children are given sedatives before extubation, which results in the prolongation of the duration of intensive care unit (ICU) stay and hospitalization time [9].

This prospective analysis examined the clinical data of pediatric CHD patients to determine the significance of FTS in radical surgery.

Materials and methods

Subjects

A total of 99 pediatric CHD patients who were admitted for treatment between March 2014 and May 2017 were selected and divided into two groups according to the random number table method. Of these, 49 patients in regular treatment group received regular ICU treatment, and the 50 patients in the fast track group received FTS. Inclusion criteria were as follows: patients who met the diagnostic criteria for CHD [10]; patients aged 6 to 24 months who undergoing radical surgery for CHD for the first time; American Society of Anesthesiologists (ASA) class I or II, no contraindications to anesthesia; Risk Adjustment for Congenital Heart Surgery (RACHS-1) Grade 2 to 4; no organ or neurologic dysfunction; and no other hereditary diseases. Exclusion criteria were as follows: patients with any other type of heart disease; patients with familial myocardial disease; and patients with complicated CHD and intraventricular mixed shunts, hemolytic diseases, any other organ dysfunction, mental disorders or incomplete medical records. Prior to this study, the protocol was approved by the Ethics Committee of our hospital, and a family member of the patient provided written informed consent.

Treatment methods

General anesthesia and surgical methods: monitoring of invasive blood pressure, central venous pressure, electrocardiogram, blood pressure, heart rate, pulse and oxygen protection was built. All patients received 0.1 mg/kg midazolam (Jiangsu Nhwa Pharmaceutical Co., Ltd.; SFDA Approval No.: H10980025) for anesthesia induction, and anesthesia was sustained with intravenous infusion of 5 μg/kg of fentanyl (Yichang Humanwell Pharmaceutical Co., Ltd.; SFDA Approval No.: H20030197) and 0.1 mg/kg vecuronium bromide (Jiangsu Hengrui Medicine Co., Ltd.; SFDA Approval No.: H2006-0869). Ventilation was performed through an orotracheal cannula, and 0.4% to 1.0% isoflurane (Shandong Keyuan Pharmaceutical Co., Ltd.; SFDA Approval No.: H20050206) was inhaled through pressure-controlled ventilation. For all patients, repair surgery was performed in case of cardiac arrest and extracorporeal circulation with ultrafiltration were instituted.

Perioperative care and management: Patients in the regular treatment group received normal nursing care, including diet and symptom management, and postoperative extubation and discharge were all implemented according to a usual strategy.

For patients in the fast track group, the rapid rehabilitation concept nursing intervention team was stablished and the members included a senior nurse as group leader and other nurses. The team members were trained in various forms by doctors with rich experience of congenital heart disease correction surgery, so that all the team members could be competent for the nursing work of children. The nursing intervention included receiving FTS with temperature management, restricted fluid resuscitation, and early access to water and food, with early postoperative extubation, a postoperative cardiopulmonary bypass (CPB)-related management strategy, pain management, customized postoperative feeding regimen and rehabilitation training program for patients, as well as early discharge of patients [11]. Regular treatment continued until the child was discharged.

Outcome measures

Before and after surgery, pulmonary arterial pressure (PAP) (Flying color ultrasonography, purchased from Lingzeng Commerce and Trade (Shanghai) Co., Ltd.) was assessed in the 2 groups, and the early extubation rate (endotracheal intubation was removed within 8 h after surgery), reintubation rate, mechanical ventilation time, treatment time in the ICU, hospitalization time, and the incidence of pulmonary complications were recorded.

Statistical analysis

SPSS 19.0 software (SPSS Inc., Chicago, IL, USA) was used for data analysis. Enumeration data in form of n (%) were compared with the Chi-square test. measurement data were expressed as means ± standard deviation.

Table 1. General data

	Regular treatment group (n=49)	Fast track group (n=50)	Statistics	*P*-value
Sex (n, %)			0.808	0.369
Male	24 (48.98)	20 (40.00)		
Female	25 (51.02)	30 (60.00)		
Age (month)	16.54 ± 5.67	16.18 ± 5.74	0.314	0.754
ASA grade (n, %)			0.264	0.607
I-II	28 (57.14)	26 (52.00)		
III	21 (42.86)	24 (48.00)		
RACHS-1			0.538	0.764
2	13 (26.53)	12 (24.00)		
3	26 (53.06)	30 (60.00)		
4	10 (20.41)	8 (16.00)		
Classify of CHD (n, %)			0.501	0.778
No tap class	5 (10.21)	4 (8.00)		
Left to right shunt classes	28 (57.14)	32 (64.00)		
Right to left shunt class	16 (32.65)	14 (28.00)		
Time of operation (min)	154.92 ± 31.17	146.69 ± 29.36	1.353	0.179
Connecting time (min)	65.17 ± 18.56	64.28 ± 16.48	0.252	0.801
Aortic cross clamp (min)	43.75 ± 22.34	37.47 ± 19.45	1.493	0.139

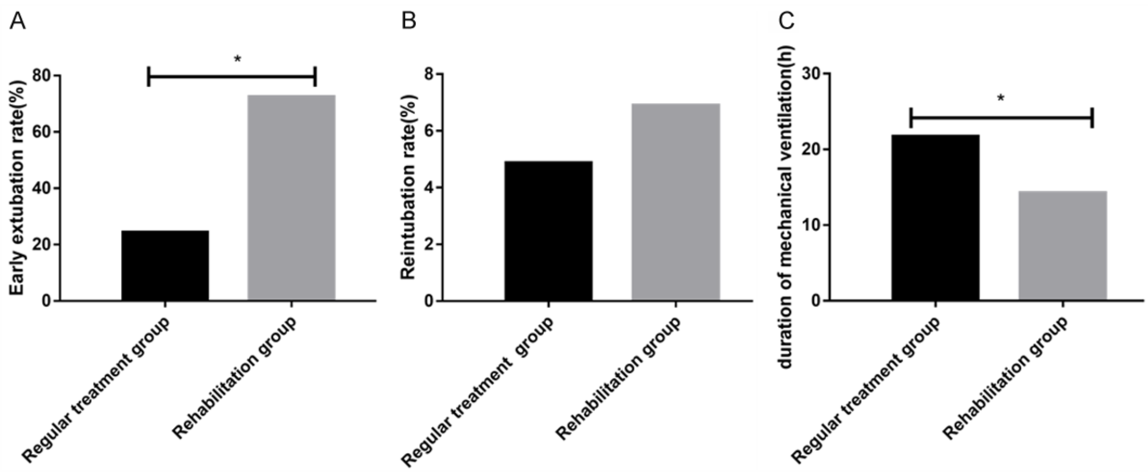

Figure 1. Comparisons of the early extubation rate, reintubation rate, and mechanical ventilation time between the 2 groups. A: Comparison of early extubation rate; B: Comparison of reintubation rate; C: Comparison of the mechanical ventilation time. *$P < 0.05$.

Comparison between two groups was compared with the independent-samples *t* test. Comparison within the group using paired t-test. $P < 0.05$ suggested that the difference had statistical significance.

Results

General data

The regular treatment group included 24 males (48.98%) and 25 females (51.02%), with an average age of 16.54 ± 5.67 months; the fast track group included 20 males 40.00%) and 30 females (60.00%), with an average age of 16.18 ± 5.74 months. Differences in general data, ASA grades, and RACHS-1 scores between the 2 groups also showed no statistical significance ($P > 0.05$). Differences in other basic data, including the types of CHD, surgical time, cardiopulmonary bypass time, and aortic cross-clamp time showed no statistical significance ($P > 0.05$) (**Table 1**).

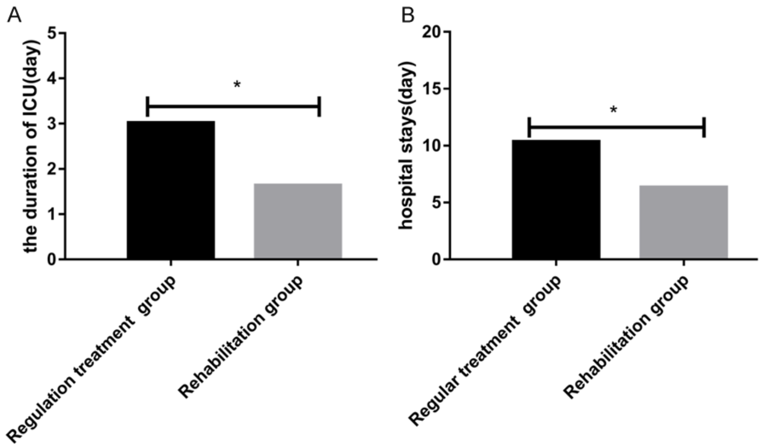

Figure 2. Comparison of the ICU treatment time and hospitalization time. A: Comparison of the ICU treatment time; B: Comparison of the hospitalization time. *$P < 0.05$.

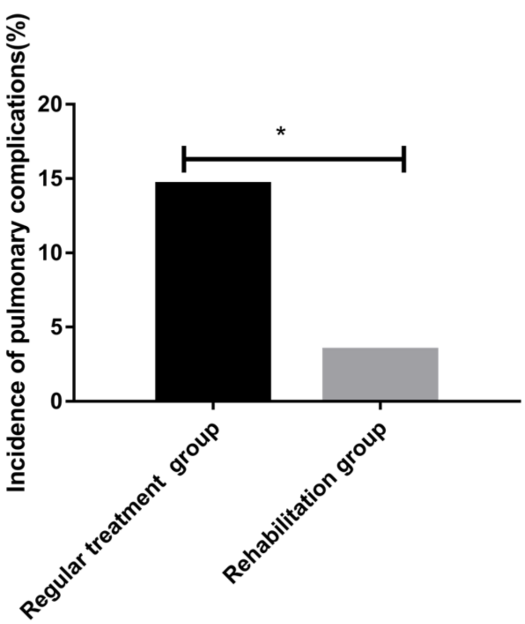

Figure 3. Comparison of the incidence rates of pulmonary complications between the two groups. *$P <$ 0.05.

Comparison of early extubation rate, reintubation rate, and mechanical ventilation time

In the regular treatment group, the early extubation rate was 24.49% (12/49), and was significantly lower than the 72.00% (36/50) in the fast track group ($P < 0.05$), while the comparison of re-extubation rates between the regular treatment group (4.08%, 2/49) and fast track group (8.00%, 4/50) showed no statistical differences ($P > 0.05$). Mechanical ventilation time in the regular treatment group was 21.72 ± 3.33 hours and was significantly longer than that, 14.25 ± 2.06 hours, in the fast track group ($P < 0.05$) (**Figure 1**).

Comparison of the ICU treatment time and hospitalization time

In the regular treatment group, the ICU treatment time was 3.02 ± 1.08 days, and was longer than the 1.64 ± 1.21 days in the fast track group ($P < 0.05$); similar differences were also identified in comparisons of the hospitalization time between the regular treatment group (10.36 ± 4.58 days) and the fast track group (6.34 ± 2.11 days) ($P < 0.05$) (**Figure 2**).

Comparison of the incidence of pulmonary complications

In the regular treatment group, the incidence of pulmonary complications was 14.29% (7/49) and was significantly higher than the rate of 4.00% (2/50) in the fast track group ($P < 0.05$) (**Figure 3**).

Changes in PAP before and after surgery

In the regular treatment group, the PAP values before and after surgery were 34.12 ± 2.13 mmHg and 27.12 ± 1.53 mmHg, respectively, while those in the rehabilitation group were 33.45 ± 2.06 mmHg and 23.86 ± 1.45 mmHg. Thus, differences in PAP between the 2 groups before surgery showed no statistical significance ($P > 0.05$). However, significant postoperative decreases were found in the 2 groups ($P < 0.05$), but the decrease in the rehabilitation group was more significant than in the regular treatment group ($P < 0.05$) (**Figure 4**).

Discussion

CHD accounts for 28% of congenital deformities, with a steady increase in incidence of CHD in the recent years [12]. Although most pediatric CHD patients have undergone radical surgery, only a small fraction recover before the age of 5 years [13]. The rapid popularization and application of the FTS concept in general surgery has led to FTS being gradually accept-

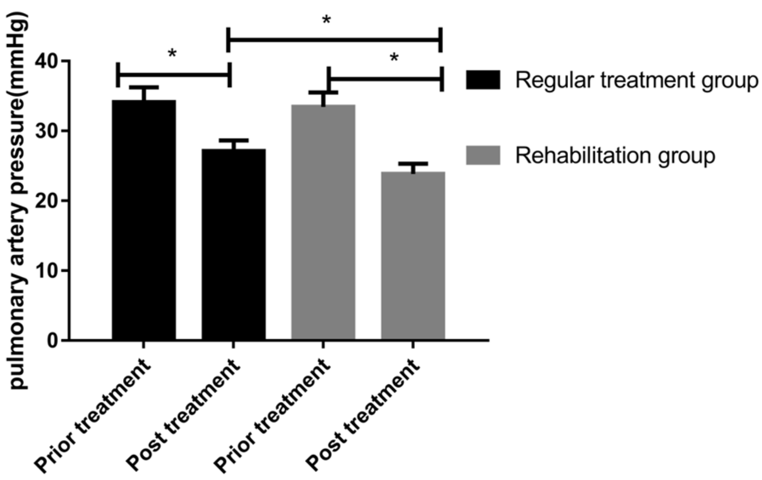

Figure 4. Changes in PAP in the 2 groups before and after surgery. $^{*}P < 0.05$.

ed in cardiac surgery; however, the applicative significance of FTS is not known in the treatment of CHD [14, 15]. Thus, this study analyzed the clinical therapeutic efficacy of 50 CHD patients who received FTS to provide reference values for clinical treatment.

The results indicated that varying degrees of decrease in PAP were observed in the 2 groups, but the decrease in the fast track group was more significant than that in the regular treatment group. As a major factor affecting the efficacy of radical surgery for CHD [16], well-controlled PAP can alleviate the severity of mitral regurgitation, thus, averting rupture of the mitral valve. The early extubation rate was lower and the mechanical ventilation time was shorter in the fast track group than that in the regular treatment group, but an increasing trend was noted in the reintubation rate in the fast track group. Early extubation is a key step in FTS, and increasing evidence suggests that long-term intubation increases the pulmonary infection rate, while recurrent aspiration of sputum also induces pulmonary arterial hypertension [17, 18]. FTS also led to a shorter mechanical ventilation time. In FTS, pain management can prevent adverse effects on the respiratory function; a decrease in pulmonary infection and atelectasis resulted in reintubation being avoided [19]. Comparison of the incidences of pulmonary complications in the 2 groups indicated a lower incidence in the fast track group than in the regular treatment group, which explained why the early extubation rate in the fast track group was lower than that in the regular treatment group. Nevertheless, differences in the reintubation rates between the 2 groups showed no statistical significance, suggesting that in FTS, early extubation does not result in an increase in the reintubation rate. This study also found that the duration of the ICU treatment and hospitalization was significantly shorter in the FTS group than in the regular treatment group, indicating that FTS can facilitate recovery after radical surgery. The results of this study show that the pulmonary arterial pressure of the two groups showed a different degree of decline after surgery, but it is obvious that the pulmonary artery pressure in the fast recovery group is lower than that in the conventional group. A very important reason for the effect of congenital heart disease treatment is postoperative pulmonary hypertension. Rational control of pulmonary artery pressure can effectively alleviate the severity of mitral regurgitation and avoid tearing of mitral valve formation [20]. Nonetheless, the number of samples in this study is small, and a large number of randomized controlled trials and evidence-based trials are still needed. The effect of FTS on long-term QOL must be studied further. Thus, this study may prompt more researchers to focus on the application of FTS during radical surgery for CHD patients.

In conclusion, for pediatric CHD patients, FTS increases the early extubation rate, shortens the ventilation time, ICU treatment time, and hospitalization time, decreases the incidence of pulmonary infection, and improves the utilization of medical resources and QOL.

Disclosure of conflict of interest

None.

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