How to do it? **Nasıl yapılır?**

The use of Yaşargil neurovascular mini-clips for patent ductus arteriosus closure in premature infants

Prematüre bebeklerde duktus arteriyozus açıklığının kapatılması için Yaşargil nörovasküler mini-klipslerinin kullanılması

Ersin Erek,[1] Yusuf Kenan Yalçınbaş,[2] Yasemin Türkekul,[3] Ayşe Ulukol,[3] Arda Saygılı,[3] Cafer Tayyar Sarıoğlu[2]

[1]Department of Cardiovascular Surgery, İstanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital, İstanbul;
[2]Department of Cardiovascular Surgery, Medicine Faculty of Acıbadem University, Acıbadem Bakırköy Hospital, İstanbul;
[3]Department of Cardiovascular Surgery, Acıbadem Bakırköy Hospital, İstanbul

Patency of ductus arteriosus (PDA) in preterm infants impairs the normal development and convalescence of the infant. Although prostaglandin inhibitors provide a conventional pharmacologic treatment with good results, some patients need surgical PDA closure. Surgical PDA closure in preterm infants necessitates special care due to the high fragility of PDA tissue. Conventional clips or ligation techniques might be traumatic and cause tearing and excessive bleeding which may be difficult to control. In this study, we report an alternative method for PDA closure in preterm infants using Yaşargil neurovascular mini-clips, which have been used for years in neurosurgery due to their atraumatic properties.

Key words: Congenital heart disease; ductus arteriosus; infant; neonate; premature.

Prematüre bebeklerde duktus arteriyozus açıklığı (PDA), bebeğin normal gelişimini ve iyileşme sürecini olumsuz etkiler. prostaglandin inhibitörler iyi sonuçları olan bir konvansiyonel farmakolojik tedavi sağlasa da bazı hastalar, PDA'nın cerrahi olarak kapatılmasına gereksinim duymaktadır. Prematüre bebeklerde PDA'nın cerrahi olarak kapatılması, PDA dokusunun frajilitesi nedeniyle özel bir dikkat gerektirir. Konvansiyonel klipsler veya ligasyon yöntemleri travmatik olabilir ve yırtılmaya ve kontrolü güç kanamalara yol açabilir. Bu çalışmada, prematüre bebeklerde PDA'nın kapatılmasında alternatif bir yöntem olarak, atravmatik özellikleri nedeniyle yıllardır beyin cerrahisi alanında kullanılan Yaşargil nörovasküler mini-klipslerinin kullanımı bildirilmektedir.

Anahtar sözcükler: Doğuştan kalp hastalığı; duktus arteriyozus; bebek; yenidoğan; prematüre.

Patency of the ductus arteriosus (PDA) in preterm infants impairs the normal convalescence of an otherwise healthy baby. The smaller the baby, the higher the incidence of PDA, which approaches 80% in infants below 1200 g body weight (BW). Clinical findings are related to the degree of left-to-right shunting, and PDA is related to the development of necrotizing enterocolitis, intracranial hemorrhage, bronchopulmonary dysplasia, and ventilatory dependence.[1,2] Although prostaglandin inhibitors, such as indomethacin and ibuprofen, provide conventional pharmacologic treatment with good results, some patients need surgical PDA closure due to resistance to these drugs, complications resulting from their usage, or relapse.[1,3]

Surgical PDA closure in preterm infants necessitates special care due to the high fragility of the PDA. The general recommendation is clip closure without

Received: February 16, 2011 *Accepted:* May 30, 2011

Correspondence: Ersin Erek, M.D. İstanbul Mehmet Akif Ersoy Göğüs Kalp Damar Cerrahisi Eğitim ve Araştırma Hastanesi, Kalp Damar Cerrahisi Kliniği, 34303 Küçükçekmece, İstanbul, Turkey. Tel: +90 212 - 692 20 00 e-mail: ersinerek@hotmail.com

circumferential dissection. Conventional clips or ligation techniques might be traumatic and may cause tearing and excessive bleeding which could be difficult to control.[3,4] In this study, we report an alternative method for PDA closure in preterm infants using Yaşargil neurovascular mini-clips which have been used for years in neurosurgery.

PATIENTS AND TECHNIQUE

From May 2008 to January 2010, five premature babies weighing 900 to 1450 g. (mean 1080±225 g.) underwent PDA closure in Acıbadem Bakırkoy Hospital. The gestational age was between 24 to 28 (mean: 26.4±1.8) weeks. The operations were undertaken between 19 and 62 days after delivery (mean 35.2±17 days). Two of the babies were twins. All patients received ibuprofen treatment before surgery. There was no response in four of the patients. Complications developed (intracranial hemorrhage grade 2 and gastrointestinal hemorrhage with acute renal failure) in two patients. The ductus reopened in one patient after initial incomplete closure with medical treatment. All patients were taken to the pediatric cardiovascular surgery intensive care unit (ICU) from neonatal ICU units of referring hospitals. All patients were on mechanical ventilatory support due to congestive heart failure and respiratory insufficiency. As diagnosed by an echocardiogram, all patients had large (considering their body weight) PDA with left-to-right shunt in an otherwise anatomically normal heart.

Invasive monitorization was performed either with direct percutaneous subclavian vein and radial artery cannulation or saphenous vein and radial artery cut-down (n=1). In one patient, invasive arterial monitorization was not possible, and a non-invasive blood pressure monitoring system was used. Patients were transferred to the operating room in their heated open bed after warming up the operating room to 26 °C. Anesthesia induction was performed with fentanyl (2 mcg/kg), midazolam (0.2 mg/kg), and pancuronium (0.1 mg/kg). Operations were performed while the patients were still in their heated open bed to prevent hypothermia.

The surgical technique used was a conventional left lateral mini-thoracotomy with the thoracic cavity being entered through the fourth intercostal space. The mediastinal pleura was opened longitudinally. Limited dissection was performed with a right-angled clamp in order to safely place a clip on the PDA. Then an angled Yaşargil neurovascular mini-clip (Yaşargil titanium aneurysm clip system) of an appropriate size was applied by using its delivery handle (Figure 1). It is possible that removal and reapplication will need to be performed several times with the same or different clips in the case of inappropriate clip size or angle. The thoracic cavity along with the chest wound was closed using a standard technique. Patients were transferred to the ICU in their beds with no interruption of heat.

No mortality or procedure-related complications were reported (Figure 2), although one patient had a pneumothorax after chest tube removal. Echocardiographic examinations confirmed the total closure of the PDA in all patients, except for one with a very small shunt (possibly due to inappropriate application of the clip) through the PDA on postoperative day one. All patients were transferred to the neonatal ICU of the referral center while they were still intubated on postoperative day one or two. All patients did well after surgery with a reduced need for oxygen and improving congestive heart failure symptoms. All patients' parents were reached by telephone six months after the operation. All patients were at home with their parents and had fully recovered. Only one patient who had preoperative intracranial bleeding had received medicine due to seizures.

DISCUSSION

Increasing survival rates have been achieved for very small premature infants thanks to recent advancements at neonatal intensive care unit facilities. Approximately

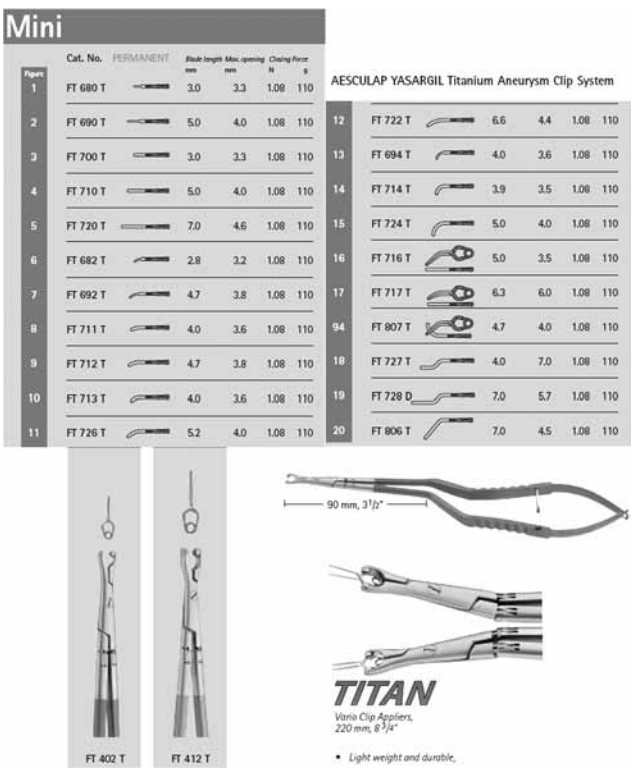

Figure 1. Samples of different sizes and delivery handles of the Yaşargil neurovascular mini-clips.

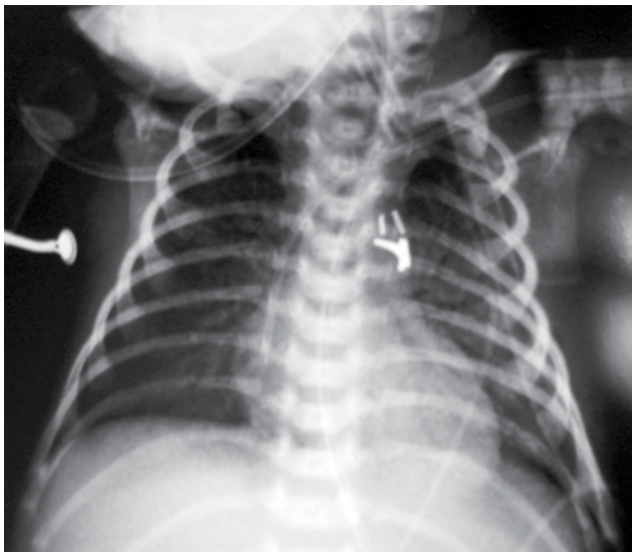

Figure 2. Postoperative telecardiogram of a baby who underwent Yaşargil neurovascular clip closure of the patency of ductus arteriosus.

45% of infants under 1750 g BW and about 80% of infants under 1200 g BW have PDA.[1] Development of difficulty in feeding, necrotizing enterocolitis (NEC), intracranial hemorrhage, renal insufficiency, bronchopulmonary dysplasia, and ventilatory dependency are potential complications for premature infants with PDA.[1,3,5] Prostaglandin inhibitors can be administered, either prophylactically or very early after the recognition of PDA, to induce pharmacological closure. Although the reported success rate of closure is between 53 to 91% with these medications, they are not free from complications. Vasoconstriction induced by bolus injection may reduce organ perfusion and may cause renal failure, intracranial hemorrhage, and neonatal necrotizing enterocolitis (NEC) in about 30% of premature infants. The relapse rate (reopening of the PDA after initial closure) is also substantial. Gersony et al.[2] reported that indomethacin resulted in closure of the ductus in 79% of the 135 treated infants, but in 26% of the cases, the ductus reopened after initial closure. Ekici et al.[1] achieved a 70% ductal closure rate in 30 premature infants. The renal dysfunction rate was 20%, and NEC developed in 16.6% of their patients. The same group also reported that 12 patients underwent surgical ligation without mortality. Necrotizing enterocolitis developed in two patients, and sepsis occurred in two patients among patients in this study. Little et al.[6] suggested that ductal ligation may be preferable to pharmacologic intervention, especially in very low BW premature infants, because of lower complication rates according to their series consisting of 212 infants. Armangil et al.[5] found no difference between single and multiple doses of indomethacin in terms of ductal closure in 29 premature infants, and they suggested that early surgical ligation may be preferable in symptomatic infants considering the higher side effects of multiple doses.

Although the benefit of surgical PDA ligation is obvious in premature infants, the surgical technique is controversial. Videothoracoscopic techniques are not applicable in these very small infants due to a lack of space for the manipulation of bulky instruments. A small thoracotomy is usually necessary. A ligaclip application is usually preferred over ligation[4,7] because circumferential dissection of the PDA might be dangerous and is not recommended. Conventional vascular ligaclips are very effective for closure of small vessels, and they have also proved effective for PDA closure. However, they have some limitations. First, after application, the clips may not be removed without injury, even in cases of inappropriate placement (e.g. incomplete closure or recurrent laryngeal nerve entrapment). The second limitation is the narrow, sharp closure surface may cause a tear and subsequent life-threatening bleeding.[4,7] In our study, we used Yaşargil neurovascular mini-clips to close the PDA. The application of one clip was sufficient for all the cases. In two cases, the mini-clips were removed easily after application and reapplied without any damage to the PDA. We used these mini-clips to temporarily close cerebral vessels during aortic arch reconstructions in neonatal babies and other infants. We have not encountered any vascular damage so far, and the mini-clips effectively closed the vessels, which were almost the same size as those in PDA. Neurosurgeons have been using these mini-clips for years to successfully repair very fragile cerebral aneurysms,[8] and our idea originated with these experiences. We have not found any study related to using Yaşargil mini-clips for closure of the PDA. Our preliminary experience has proven that Yaşargil neurovascular mini-clips are very effective, easy to use, atraumatic, and safe for surgical PDA closure. There are many types with different lengths and angles, and they are also MRI compatible. Although the price is higher than conventional ligaclips, we think that their safety and applicability facilitates the procedure. Although our series was small, the Yaşargil neurovascular mini-clips may be an effective alternative for closing the PDA in premature infants. Long-term follow-up studies with large series are necessary to prove the safety and effectiveness of the procedure.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Ekici F, Atasay B, Günlemez A, Naçar N, Tutar E, Atalay S, et al. Management of patent ductus arteriosus in preterm infants. Anadolu Kardiyol Derg 2006;6:28-33.
2. Gersony WM, Peckham GJ, Ellison RC, Miettinen OS, Nadas AS. Effects of indomethacin in premature infants with patent ductus arteriosus: results of a national collaborative study. J Pediatr 1983;102:895-906.
3. Canarelli JP, Poulain H, Clamadieu C, Ricard J, Maingourd Y, Quintard JM. Ligation of the patent ductus arteriosus in premature infants-indications and procedures. Eur J Pediatr Surg 1993;3:3-5.
4. Russell JL, Leblanc JG, Potts JE, Sett SS. Is surgical closure of patent ductus arteriosus a safe procedure in premature infants? Int Surg 1998;83:358-60.
5. Armangil D, Yurdakök M, Karagöz T, Canpolat FE, Korkmaz A, Yiğit Ş ve ark. The retrospective analysis of premature infants with patent ductus arteriosus ligation in the neonatal intensive care unit. Çocuk Sağlığı ve Hastalıkları Dergisi 2008;51:187-92.
6. Little DC, Pratt TC, Blalock SE, Krauss DR, Cooney DR, Custer MD. Patent ductus arteriosus in micropreemies and full-term infants: the relative merits of surgical ligation versus indomethacin treatment. J Pediatr Surg 2003;38:492-6.
7. Mandhan PL, Samarakkody U, Brown S, Kukkady A, Maoate K, Blakelock R, et al. Comparison of suture ligation and clip application for the treatment of patent ductus arteriosus in preterm neonates. J Thorac Cardiovasc Surg 2006;132:672-4.
8. Otawara Y, Ogasawara K, Kashimura H, Kubo Y, Ogawa A, Watanabe K. Mechanical characteristics and surface elemental composition of a Yasargil titanium aneurysm clip after long-term implantation. J Neurosurg 2010;112:1260-2.