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Late Termination of Pregnancy: Experience From an East Asian Population and Report of a Novel Technique for Feticide

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We report our experience of late feticide in Taiwan as well as a novel technique, fetal cardiac tamponade, which can be used in the late termination of pregnancy. Twenty-six patients who elected to undergo feticide were enrolled in this study (among 40 pregnancies with fetal abnormalities diagnosed late in gestation during 2005–2008 in a tertiary referral center in Taiwan). The fetal abnormalities in these patients included structural malformations and/or genetic defects. This study conformed strictly to the regulation of law and was approved by the Institutional Review Board/Ethics Committee of the Changhua Christian Hospital. Two methods were used to perform feticide: intracardiac injection of potassium chloride (6 mmol) and intracardiac injection of lidocaine (10 mL in 2% preparation). If fetal asystole was not achieved 3 minutes after initial injection, fetal cardiac tamponade was then performed by instilling normal saline into the fetal pericardium. Permanent cessation of fetal heart activity was regarded as successful feticide. The gestational age of the feticide group ranged from 24 to 38 weeks (mean, 30.85 ± 3.77 weeks). The body weight of the aborted fetuses ranged from 675 g to 2,860 g (mean, 1,618.1 ± 590.7 g). The use of lidocaine was successful in six of the seven cases (85.7% success rate). The use of potassium chloride was successful in 11 of the 19 cases (57.9% success rate). Fetal cardiac tamponade as a salvage technique was performed in nine cases, including eight cases in which pumping of the fetal heart resumed following potassium chloride administration and in one case when lidocaine alone failed to achieve permanent cessation of fetal heart activity. The success rate of fetal cardiac tamponade as a salvage technique was therefore 100%. No maternal complications were noted in our series. Fetal cardiac tamponade is a useful and safe supplementary technique in late feticide when cardiac depressing agents fail to cease fetal cardiac activity.

KEY WORDS — cardiac tamponade, feticide, late termination of pregnancy

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Introduction

Abortion is controversial in most cultures when the fetus approaches or has reached viability. It has been legal in Taiwan since 1985, when the gestation period is less than 24 weeks long. The law was amended in 2000 to allow abortions beyond 24 weeks' gestation. Under Taiwanese law and by the consensus of professional societies, late abortion is defined as termination of pregnancy after 24 weeks of gestation [1]. Despite the fact that fetal screening techniques are currently very advanced, diagnostic confirmation of some fetal diseases can only be established late in gestation. Late termination introduced in these rare situations is stressful both for the patients and doctors. The media and government authorities in Taiwan became aware of this difficult issue in 2005 after a controversial case which attracted nationwide concern. The case which involved a 35-week fetus with complex heart disease and Down syndrome received a feticide which resulted in heated debate after being reported by a local tabloid. A guideline was therefore introduced by the Taiwan Association of Obstetrics and Gynecology to regulate this practice [1]. Selective feticide is sometimes indicated in multifetal pregnancies late in gestation, for example, to reverse preeclampsia or mirror syndrome, in multifetal pregnancies in which one fetus has hydrops, to reduce twins with one severe fetal anomaly, or to reduce the acardiac twin in monochorionic twin pregnancies complicated by twin reversed arterial perfusion [2–5].

Intracardiac injection of potassium chloride is recommended by the Royal College of Obstetricians and Gynaecologists to ensure fetal asystole [6]. Due to concerns regarding fetal pain, funipuncture with injections of sufentanil followed by potassium chloride was suggested [7]. However, maternal spillage is always a fear. Therefore, umbilical vein injection of sufentanil followed by lidocaine was proposed as a safer alternative which had a success rate of 92%, in which 46 of the 50 fetuses had complete cessation of cardiac activity, while the intracardiac injection of lidocaine or potassium chloride was still needed in four cases [8]. Resistance to lidocaine,

and even to potassium chloride, was observed in large fetuses especially in those near-term. Since the Royal College of Gynaecologists and Obstetricians has stressed that all late terminations should ensure that the fetus is born dead and fetal cardiac activity should be stopped before abortion is initiated [9–11], a method or a stepwise strategy with 100% success rate and safety should be developed. Thus, we were keen to develop our own method which we consider would be suitable for our own setting. Intrathoracic autologous amniotic fluid injection was reported to be successful in multifetal pregnancies in the first trimester [12]. This gave us the idea that cardiac tamponade achieved either by autologous amniotic fluid or normal saline may also be effective, or at least supplementary, in feticide performed at late gestation.

We report our experience of late termination of pregnancy (>24 complete weeks of gestation) when comparing the success rate of different methods (intracardiac injection of potassium chloride or lidocaine) at a Taiwan tertiary referral center, and describe a novel technique (fetal cardiac tamponade) which can be used in the late termination of pregnancy.

Materials and Methods

Between August 2005 and December 2008, 504 pregnancies with fetal abnormalities were encountered in a tertiary referral medical center (Changhua Christian Hospital) in Taiwan. Among these pregnancies, 40 patients had fetal abnormalities which were first diagnosed later than 24 weeks of gestation. Twenty-six singleton pregnancies requested late termination and feticide was performed by one of the authors (Ming Chen) for severe fetal anomalies (Table). There were no maternal indications, such as medical diseases, for late termination of pregnancy in our series. All patients received a comprehensive explanation and a multidisciplinary consultation (including two perinatal specialists, one psychiatric specialist, one social worker, and related subspecialists such as pediatric cardiac surgeon,

Table. Details of fetal abnormalities and late termination of pregnancy

Case*	Malformation/genetic defect	Gestational age at feticide (wk)	Birth weight (g)	Sex	Method	Delivery
1	Unbalanced translocation	31	1,520	F	B1	V
2	Complex heart disease	26	1,000	M	A1	S
3	Bilateral renal agenesis	31	1,380	M	A1	V
4	Agenesis of corpus callosum	29	1,300	F	A1	S
5	Dandy-Walker malformation	33	1,760	M	A1	S
6	Microcephaly (due to concealed placental abruption)	34	2,000	F	A2	V
7	Arthrogyriposis multiplex congenita	35	2,400	F	A1	S
8	Jejunal atresia	36	2,860	F	A1	S
9	Trisomy 18	31	1,240	F	A1	V
10	Cystic fibrosis	35	2,495	F	A1	V
11	Trisomy 21, cardiac and hepatic involvement	34	2,210	M	A2	V
12	Unbalanced translocation	38	2,495	F	A2	V
13	Complex heart disease	27	1,020	M	A2	V
14	Plagiocephaly, choledochal cyst	33	1,830	M	A2	V
15	Trisomy 21	30	1,400	F	A2	S
16	Truncus arteriosus	28	1,250	M	A2	S
17	Hypoplastic left heart	30	1,520	F	A2	V
18	Unbalanced translocation	37	1,740	M	A1	S
19	Hydrops fetalis, bilateral chylothorax, cystic hygroma, duodenal atresia	30	1,380	F	B1	S
20	Add(18)(SKY+, 18qter-)	25	735	M	A1	V
21	Hydranencephaly	30	2,080	F	B1	V
22	Fetal Down syndrome i(21)(q10)	25	870	M	A1	V
23	Sacrococegeal teratoma, hydrocephalus	32	2,290	F	B1	S
24	Esophageal atresia, TOF	29	1,120	F	B1	V
25	Congenital diaphragmatic hernia	29	1,500	M	B2	V
26	Multicystic dysplastic kidney disease, bilateral	24	675	F	B1	S

*Cases are arranged in chronological order as they were enrolled and treated. A1 = potassium chloride only; A2 = potassium chloride plus cardiac tamponade by normal saline; B1 = lidocaine only; B2 = lidocaine plus cardiac tamponade; S = cesareans; V = vaginal; TOF = tetralogy of Fallot.

medical geneticist, and religious workers) before the procedure. The gestational age of the fetuses ranged from 24 to 38 weeks. Patients were randomized into two groups. Feticide was performed under ultrasound guidance with a 21-gauge needle by one of the two methods as follows: (A) intracardiac injection of potassium chloride (6 mmol) to stop fetal heart beat or (B) intracardiac lidocaine (10 mL

in 2% preparation) injection. A random list was prepared using a computer-generated number list. Odd numbers evaluated the use of potassium chloride (method A) and even numbers evaluated the use of lidocaine (method B). If fetal heartbeat was not stopped 3 minutes after the initial procedure, concomitant fetal cardiac tamponade by instillation of normal saline (10–20 mL) into the pericardium was

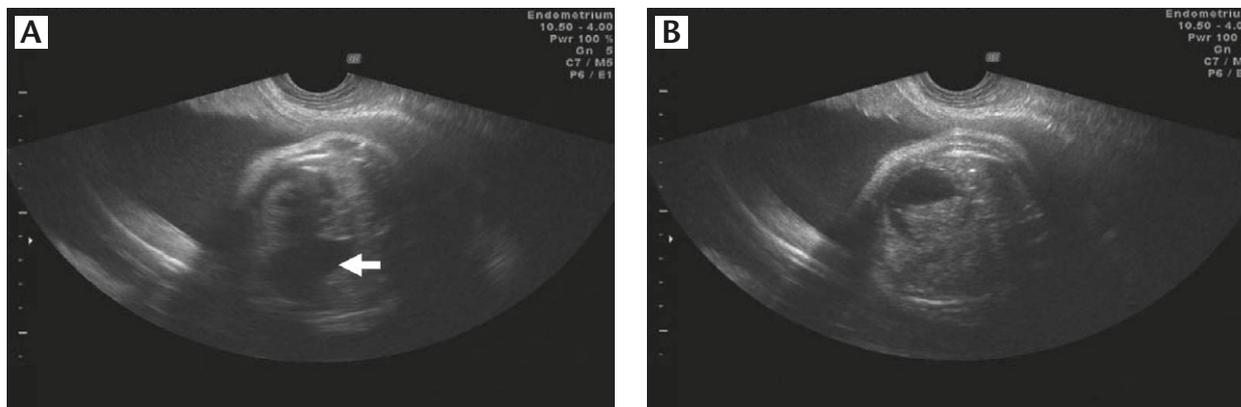


Fig. Ultrasound image of the thoracic cavity (white arrow denotes the misplaced stomach) in a 29-week gestational age fetus with congenital diaphragmatic hernia (A) before and (B) after cardiac tamponade.

then performed as a salvage method (Fig.). The institutional review board of our hospitals approved these cases by reviewing each applicant case by case according to the individual situation. Mode of delivery was determined by obstetric considerations.

Results

The Table shows the details of our series. The gestational age ranged from 24 to 38 weeks (mean, 30.85 ± 3.77 weeks). The fetus body weight ranged from 675 to 2,860 g (mean, $1,618.1 \pm 590.7$ g). Resumed pumping of the fetal heart was considered treatment failure. The fetal abnormalities noted in 26 cases included eight fetuses with chromosomal aneuploidy and 18 fetuses with structural malformations without detectable aneuploidy. Among the 18 fetuses with structural abnormalities but without detectable aneuploidy, five had congenital heart defects, five had nervous system malformations, two had bilateral renal anomalies, two had gastrointestinal malformations (including one combined with Tetralogy of Fallot), one had plagiocephaly combined with choledochal cyst, one had arthrogryposis multiplex congenita, one had hydrops fetalis, one had congenital diaphragmatic hernia, and one had cystic fibrosis.

The use of lidocaine was successful in six of the seven cases (85.7% success rate). Potassium chloride alone was successful in 11 of the 19 cases (57.9%

success rate); however, with the supplementary use of fetal cardiac tamponade, cessation of fetal heart activity was noted in the remaining cases where potassium chloride or lidocaine failed to stop fetal heart activity (the success of this salvage technique was therefore 100%). Notably, 14 of the fetuses in our series had either high birth weights ($> 1,500$ g) or had later gestational age (> 34 weeks). These more mature fetuses may have been more resistant to low doses of potassium chloride and lidocaine, as 19 of them received potassium chloride injection and eight of them needed salvage fetal cardiac tamponade to achieve successful feticide (success rate of potassium chloride in this group was only 57.9%). There were no maternal complications in our series. Eleven cases were delivered by cesarean section. The rate of cesarean section was 42.3%. The post-feticide psychological state was carefully followed up by nurse practitioners and psychiatrists. No psychosocial disturbance was noted in any of our patients.

Discussion

Potassium chloride is the standard procedure used for feticide worldwide. However, the effects and maternal spillage of this technique have always been a concern. In our series, the use of potassium chloride was not satisfactory for larger fetuses, which corresponds well with other reports [7]. Eight of the

17 fetuses who weighed more than 1,000 g (Case 6, 11–17 in Table) failed to completely stop cardiac activity after the initial dose (6 mmol) of potassium chloride alone (success rate 53% in large fetuses). With concerns of possible leakage of the medication through the placenta into the maternal circulation, we only used low dose potassium chloride. Furthermore, potassium chloride has been reported to increase tissue autolysis and increase the difficulty of CNS autopsy or microscopy [13]. We used pericardial instillation of normal saline in those failed cases (Table, method A2) to achieve fetal cardiac tamponade, which is a novel approach in late gestation, to achieve complete cessation of fetal cardiac activity. This method is less likely to cause complications such as maternal cardiac arrest since the amount of potassium chloride used can be reduced. This technique achieved an acceptable success rate in our series (100%, 8/8). Interestingly, we observed a higher preliminary success rate (85.7%, 6/7) when we used lidocaine instead of potassium chloride. However, one of these seven fetuses failed following the initial dose (10 mL in 2% preparation) and this fetus had a gestational age less than 32 weeks. Only one case in Senat et al's series failed to respond to lidocaine and needed an extra intracardiac injection of potassium chloride and was the largest fetus in the series (body weight, 2,900 g) [8]. It is possible that we may still need cardiac tamponade as a supplementary rescue in future cases despite the use of lidocaine. The major advantage of using lidocaine instead of potassium chloride is reduced maternal toxicity because the transplacental passage would be below the toxic dose [8]. However, due to safety concerns, we still used a fixed dose without any increment.

Whether fetuses have the sensation of pain or not, and whether they should be anesthetized before feticide, are issues under debate. We were aware that there is evidence to show that fetal pain and awareness are very likely to exist after 26 weeks of gestation when thalamo-cortical neuron connections are established [14] and intrathoracic or intracardiac puncture may be painful. The method reported by Senat et al [8] involves the use of

lidocaine (with much less toxicity) and analgesia achieved by funipuncture which would make the feticide procedure more humane. However, other authors consider this unnecessary for funipuncture because fetal asystole is rapidly achieved by the intracardiac approach when potassium chloride is successful. Besides, funipuncture is sometimes technically challenging when the position of the cord insertion is less feasible in certain circumstances [11]. In our opinion, maternal complications are a much greater concern to us in our socioeconomic setting, thus we decided to reduce the amount of the pharmaceuticals used and tried to adopt a supplementary method without adding more cardiac-depressing agents. There is no apparent difference between the intracardiac route and the funipuncture route except the concern of fetal awareness and fetal pain. In those circumstances, we consider that cardiac tamponade with intrathoracic injection of normal saline may at least be better than using cardiac-depressing agents such as lidocaine or potassium chloride. Thus, this novel method developed by us for late gestation may still have a supplementary role in the late termination of pregnancy, especially in those resistant to lidocaine or potassium chloride. In addition, in multifetal pregnancies with one fetus indicated for feticide, cardiac tamponade may deserve further investigation to assess whether it can serve as a simple technique for selective feticide. In our opinion, injecting lidocaine into the fetal chest and skin may also offer some pain relief before the needle finally pierces the pericardium and the heart.

Studies carried out elsewhere in the world have also devised various novel medication-free methods of feticide including cord ligation, cord coagulation, radiofrequency ablation, and intracardiac blood aspiration [2–4,15–17]. Needless to say, these methods either need sophisticated equipment such as operative fetoscopy and radiofrequency facilities, or the theoretical risk of iatrogenic fetal anemia in one cotwin cannot be excluded if anastomoses between the cotwins exist and feticide is performed by intracardiac blood aspiration. Moreover, nonselective embryo reduction in multifetal pregnancy is

claimed by some authors to be malpractice and should be avoided [18]. However, even if only one embryo is transferred in infertility treatments there is still an increased risk of monozygotic twinning if assisted reproductive techniques such as assisted hatching are involved [19], which further mandates the need to develop highly selective and medication-free methods of selective feticide.

Our cases were delivered by obstetric indication following feticide. Eleven of these cases underwent cesarean section. The rate of cesarean section was 42.3%. As we are aware, the rate of cesarean section in Taiwan is one of the highest in the world. The average rate of cesarean section in Taiwan in 2004 was reported to be around 34%, which is higher than the level of 15% recommended by World Health Organization [20]. Included in this rate were repeat cesarean sections which constituted the majority of cases. The emotional stress in parents is high during feticide and termination [21]. The uncertainty of the time spent waiting for delivery during intrapartum and the risk of uterine rupture may be the reasons why women chose to undergo cesarean section if they had previously done so.

We carry out feticide in our institution, and despite approval by our law under strict regulations, feticide is a highly controversial issue. Even in a generally liberal society such as the United Kingdom, where there is no gestational age limit when performing abortion, individual differences do exist as to the types of fetal abnormalities fetal medical experts prefer not be involved in with regard to pregnancy termination [22]. With the advent of advanced diagnostic modalities, whether non-invasive or invasive, the rate of fetal abnormalities diagnosed later than 24 weeks of gestation in our institution was only 7.9% (40/504). In addition, despite 65% (26/40) of patients whose fetal abnormalities were diagnosed late and who elected late termination of pregnancy, 35% of patients chose to continue their pregnancy. We do not intend to discuss this complex issue here but would like to report that if feticide is performed, fetal cardiac tamponade appears to be a safe procedure for mothers

since it is medication-free. It also does not contradict human concerns if fetal analgesia can be achieved prior to the procedure.

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References

1. Chiang S. Late abortion: a comprehensive review. *Taiwan J Obstet Gynecol* 2005;44:318–26.
2. Heyborne KD, Chism DM. Reverse of Ballantyne syndrome by selective second-trimester fetal termination. *J Reprod Med* 2000;45:360–2.
3. Tsao KJ, Feldstein VA, Albanese CT, et al. Selective reduction of acardiac twin by radiofrequency ablation. *Am J Obstet Gynecol* 2002;187:635–40.
4. Audibert F, Saloman LJ, Frydman R. Selective feticide reverses preeclampsia in discordant twins. *Am J Obstet Gynecol* 2005;193:894. [Letter]
5. Chang YL, Chao AS, Hsu JJ, et al. Selective feticide reversed mirror syndrome in a dichorionic triplet pregnancy with severe twin-twin transfusion syndrome: a case report. *Fetal Diagn Ther* 2007;22:428–30.
6. Royal College of Obstetricians and Gynaecologists. *Further Issues Relating to Late Abortion, Fetal Viability and Registration of Birth and Deaths*. London: RCOG Press; 2001.
7. Senat MV, Fischer C, Ville Y. Funipuncture for feticide in late termination of pregnancy. *Prenat Diagn* 2002;22:354–6.
8. Senat MV, Fischer C, Bernard JP, et al. The use of lidocaine for feticide in late termination of pregnancy. *BJOG* 2003;110:296–300.
9. Royal College of Obstetricians and Gynaecologists. *Termination of Pregnancy for Fetal Abnormality in England, Wales, and Scotland*. London: RCOG Press; 1996.
10. Royal College of Obstetricians and Gynaecologists Ethics Committee. *Late Termination of Pregnancy for Fetal Abnormality: A Consideration of the Law and Ethics*. London: RCOG Press; 1998.

11. Pasquini L, Pontello V, Kumar S. Intracardiac injection of potassium chloride as method for feticide: experience from a single UK tertiary center. *BJOG* 2008; 115:528–31.
12. Horng SG, Wang CW, Huang HY, et al. Successful outcome of intrathoracic injection of autologous amniotic fluid in fetal reduction: report of two cases. *J Assist Reprod Genet* 2004;29:343–5.
13. Gill P, Cyr D, Afrakhtah M, et al. Induction of fetal demise in advanced pregnancy terminations: report on a funic potassium chloride protocol. *Fetal Diagn Ther* 1994;9:278–82.
14. Smith R, Gitau R, Glover V, et al. Pain and stress in the human fetus. *Eur J Obstet Gynecol Reprod Biol* 2000; 92:161–5.
15. Beksac MS, Balci S, Ozlü T, et al. Selective feticide in dichorionic pregnancies with intracardiac blood aspiration: report of nine cases. *J Perinat Med* 2008;37: 85–6.
16. Middeldorp JM, Klumper FJ, Oepkes D, et al. Selective feticide in monoamniotic twin pregnancies by umbilical cord occlusion and transection. *Fetal Diagn Ther* 2008;23:121–5.
17. Diehl W, Hecher K. Selective cord coagulation in acardiac twins. *Semin Fetal Neonatal Med* 2007;12: 458–63.
18. Saugstad OD. Non-selective fetal reduction is malpractice. *J Perinat Med* 2006;344:355–8.
19. Miura K, Nikawa N. Do monozygotic twins increase after pregnancy by assisted reproductive technology? *J Hum Genet* 2005;50:1–6.
20. World Health Organization. Appropriate technology for birth. *Lancet* 1985;2:436–7.
21. Kersting A, Kroker K, Steinhard J, et al. Psychological impact on women after second and third trimester termination of pregnancy due to fetal anomalies versus women after preterm birth—a 14-month follow up study. *Arch Womens Ment Health*. 2009;12:193–201.
22. Statham H, Solomou W, Green J. Late termination of pregnancy: law, policy and decision making in four English fetal medicine units. *BJOG* 2006;113: 1402–11.