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10. The regulatory environment of multifetal pregnancy reduction: a comparative case study of Italy and Japan

Mio Tamakoshi

INTRODUCTION

Abortion and medically assisted reproduction (MAR) are vital components of the politics of reproduction. They are medical interventions that are intended to serve opposite reproductive outcomes; whereas abortion is performed to terminate pregnancy, MAR is utilized to initiate pregnancy and achieve live birth. The social science literature on these two topics has mostly explored these topics in isolation from each other (van de Wiel, 2022). Whereas abortion politics has a long history, which has been extensively studied in its own right, MAR is a relatively new subject; after all, the first “tube baby” was only born from in vitro fertilization (IVF) in 1978. The socioeconomic profile of MAR and abortion clients may also have contributed to how the two fields have been researched; the abortion rate is higher among women of lower socioeconomic status than among their affluent counterparts, while MAR is more often utilized by members of the middle class, who can afford the expensive treatment (Bell, 2014; Dehlendorf et al., 2013). However, both abortion and MAR can be understood as part of reproduction, that is, “the biological and social process of having or not having children” (Almeling, 2015, p. 430).

Looking at both abortion and MAR regulations together can illuminate a broader context of reproduction policy as a regulatory domain. Because both abortion and MAR involve the same legal and ethical issues – including the beginning of life, the status of the unborn and the state’s responsibility for human life – regulations and regulatory debates on each of these interventions may pave the way for politicization of the other (van de Wiel, 2022). Existing debates on abortion can prepare the conceptual and political resources that actors utilize in the development of regulations on reproductive technologies. For example, comparing British, American and German regulations on embryo

research, Jasanoff (2011) highlights that preceding or concurrent abortion debates surrounding the origin of life, the foetal status and limits on abortion have influenced the framing of controversies that emerged in MAR regulatory discussions. Yet, MAR regulations, which are newer than abortion regulations in many countries, may trigger the re-emergence of previously settled abortion debates. Calloni (2001) observes that during the legislative discussion of IVF regulations in Italy in the 1990s, the subject of the legal and ethical status of embryos and the unborn was brought up in the parliament, and some legislators sought a restrictive amendment to the abortion law that had passed in 1978.

The cross-agenda reference between abortion and MAR regulations not only occurs in such a spill-over way, but also more directly. One showcase for their interrelations is the regulation of multifetal pregnancy reduction (MFPR), a procedure to reduce one or more live foetuses in multiple pregnancies. Multiple pregnancy can occur in spontaneous pregnancy, but the incidence has dramatically increased owing to the widespread use of reproductive technologies. As it is associated with higher risks to foetal and maternal health than singleton pregnancy, multiple pregnancy is considered to be one of the most important adverse outcomes of MAR (Olivennes, 2000). Thus, MFPR is usually regulated in the context of MAR; however, regulations on MFPR need to address the issue of abortion because the procedure involves, at least partly, voluntary termination of foetal development.

The present study compares the regulations and regulatory discussions on MFPR in Italy and Japan, following a most-similar systems design (Ankar, 2020; Przeworski & Teune, 1982); the two countries share socio-structural features relevant to reproduction, while showing a stark contrast in the MAR regulatory arrangement. By investigating the two country cases comparatively, this study addresses a two-sided question. First, what difference in MAR regulatory structures can empirically explain the different regulations on MFPR between the two cases? The chapter aims to explain the diverging responses to the issue of MAR-induced multiple pregnancy and the legality of MFPR by analysing the different regulatory arrangements that condition the level of professional autonomy of gynaecologists from legislative control. Second, how do the regulations of MFPR within the context of MAR refer to and interpret the abortion legislation in the respective country? In other words, the study investigates how the regulations of MFPR as part of MAR treatments have legalized or restricted the procedure of MFPR in relation to abortion. By answering these questions, the study aims to articulate how MAR and abortion regulations form part of a broader context of reproduction policy as a regulatory domain.

This chapter first gives a brief overview of multifetal pregnancy reduction. It then goes on to introduce the analytical and comparative perspective the study takes, drawing on science and technology studies (STS). After explaining the case selection and providing an outline of both abortion and MAR

regulations in Japan and Italy, the chapter reviews regulations and regulatory debates surrounding MFPR in both countries. Drawing on the comparison, it discusses how the different regulatory structures in the field of MAR have led to the divergent legal statuses of MFPR, as well as how the focus point of the respective abortion laws can be illuminated by the MFPR regulations in the two countries.

BACKGROUND: MFPR

Multifetal pregnancy reduction (MFPR) is a first-trimester or early second-trimester procedure to interrupt the development of one or more foetuses in multiple gestation. The standard procedure of MFPR is performed by a transabdominal injection of potassium chloride (KCl) to the heart of the foetus(es) (Berkowitz et al., 1996). Developed in the 1980s, the procedure has been used in order to reduce risks associated with multiple gestation, including foeto-maternal morbidity and mortality (Evans et al., 1996). While twin and triplet pregnancy can occur in spontaneous gestation, the increased use of medically assisted reproductive technologies (MAR) has led to the greater incidence of higher-order pregnancy. Multiple pregnancy following MAR is especially frequent with ovarian stimulation, which may produce multiple follicles. It is also common when in vitro fertilization (IVF) is carried out with more than one embryo transferred per cycle (Berkowitz et al., 1996; Maymon et al., 1995). Thus, the circumstances in which MFPR is performed are strongly associated with the use of reproductive technologies which seek to initiate pregnancy and achieve live birth. Meanwhile, MFPR shares a feature with abortion: both involve a voluntary interruption of the foetal development in an already-initiated pregnancy. MAR patients who undergo MFPR do not terminate the entire pregnancy, which is what occurs when abortion is conventionally performed, but instead carry the rest of the live foetuses conceived with MAR to term.

As it involves ethical and legal issues and puts a significant psychological burden on the pregnant person and their partner, MFPR is usually recommended by MAR experts “as a last resort only secondary to prevention of multiple pregnancy from the first place” (ESHRE Workshop Group, 2000, p. 1863). In fact, since the mid-1990s, technologies and practices have been developed to avoid multiple pregnancy following MAR. For example, ultrasound examination is utilized to inspect the number of follicles after ovulation induction and, when a high number of follicles is observed, the insemination attempt is postponed until another cycle. In several countries, medical guidelines have encouraged single or low numbers of embryo(s) transferred per cycle in IVF treatment. However, multiple pregnancy resulting from MAR

cannot be entirely prevented by these circumventory measures in today's medicine.

ANALYTICAL PERSPECTIVE

Drawing on the tradition of comparing policies in science and technology studies (STS), this study conducts interpretive analysis of MFPR regulations. Whereas comparative studies, especially in policy research, have conventionally aimed at identifying best practices to imitate in another context, the STS literature emphasizes the embeddedness of knowledge and policy in a specific context and suggests that a mere transplant of such best practices that pays little attention to cultural and other specificities may fail (Jasanoff, 2011; Markle et al., 2001). Inspired by this, the current study takes a comparative perspective to scrutinize differences in MFPR regulations between two countries and to observe how medical practices and regulations develop interactively in the field of reproductive medicine.

First, through a cross-country comparison of MFPR regulations, types and approaches in MAR and abortion policies respectively may be identified. On the one hand, MFPR is usually subject to MAR regulations, which vary strongly across countries (Pennings, 2009). Countries differ in what sorts of MAR treatments are permitted and prohibited, reflecting the ethical, religious and legal standpoints of the regulators. Moreover, the regulatory structure of MAR differs by country. Different actors, such as legislators, ministerial organs and professional associations of gynaecologists are involved in the making of such regulations on the use of MAR in different countries. On the other hand, MFPR regulation touches upon abortion regulations, which also vary widely across countries. Abortion laws convey cultural, religious and political meanings surrounding and assigned to reproduction. Thus, the cross-country comparison of MFPR regulations in the current study helps to identify variations in the policy fields of MAR and abortion simultaneously.

Second, because MFPR concerns both MAR and abortion, an analysis of regulatory landscapes surrounding MFPR contributes to understanding how these two different fields intersect and interact with each other. This provides a more comprehensive view of the regulatory domain of reproduction policy. By comparing how MFPR regulations within the MAR regulatory contexts refer to and interpret the abortion laws in each country, the study enables exploring the inter-policy dependencies in the realm of reproduction policy. Regulations of MFPR are a unique subject in a cross-country comparative analysis that seeks to understand interrelations among different sub-fields of reproduction policy.

CASE SELECTION

This chapter looks comparatively at MFPR regulations in Italy and Japan. The case selection resembles a most-similar systems design (Anckar, 2020; Przeworski & Teune, 1982), with both countries showing important structural commonalities but strong differences in the MAR regulatory arrangement. First, the two countries share certain societal features that are relevant to reproduction. Southern Europe and East Asia are often compared in terms of historical development and the organization of welfare states. Both regions are characterized by strong *familialism*, that is, a great emphasis on the family as a welfare provider, predicated on conservative teachings on family in Catholicism and Confucianism (Collier & Mahon, 1993; Naldini, 2004). Furthermore, both Japan and Italy are facing a lowest-low fertility rate while the populations are rapidly aging. This renders the matter of reproduction ever more pressing for policymakers in both countries. The high prevalence of infertility along with the societal change, including postponement of child-bearing also adds to the importance of reproduction policy, especially in the field of MAR, to people in both societies.

Second, the abortion regulations in Japan and Italy are similar. Abortion remains in the Penal Code in both countries, while specific law exempts the criminality under certain circumstances. In Japan, abortion was criminalized in 1907 under the Imperial government (Articles 212–216 in the Penal Code). However, as part of the population control policies in the post-war period, the Eugenic Protection Law (優生保護法) passed in 1948 (renamed to Maternal Protection Act (母体保護法) in 1996). The law permits abortion up to the foetal viability, marked by the ability of a human foetus to survive outside the uterus.¹ This applies to cases in which the pregnancy may cause serious harm to the mother's health for physical or economic reasons as well as in cases of incest or rape.

In Italy, the abortion ban was included in the Penal Code under the Fascist regime in 1930 (Articles 545–551). Despite democratization in the post-war period, many pieces of Fascist legislation remained in place, including abortion prohibition. However, in 1978, Law no. 194 “Norme per la Tutela Sociale della Maternità e sull’Interruzione Volontaria della Gravidanza” (Regulations on the Social Protection of Motherhood and about the Voluntary Interruption of Pregnancy) was approved by the parliament. This law legalizes abortion within the first 90 days of gestation when pregnancy threatens the pregnant woman's physical or mental health, including economic, social or family conditions. As such, whereas several countries have completely decriminalized abortion, both Italy and Japan have kept abortion in the criminal code, but established certain conditions under which abortion can be legally performed.

Third, the countries exhibit great differences in the regulatory organization in the field of medically assisted reproduction. Italy used to be regarded as “the Wild West” in the fertility industry for a long time due to the absence of relevant regulations. After two decades of legislative attempts, Law no. 40 “Norme in materia di procreazione medicalmente assistita” (Regulations on Medically Assisted Procreation) passed in 2004, which was the most restrictive MAR regulation in Europe at the time (Robertson, 2004). The law established a ministerial guideline, which is updated every three years and binding for all the authorized fertility clinics that can perform MAR services. Meanwhile, Japan has no legislative regulation of MAR up to today. In Japan, MAR is primarily governed by organizational guidelines issued by the Japan Society of Obstetrics and Gynaecology (JSOG). The stark contrast in the regulatory structure in the field of MAR helps to empirically analyse the difference in MFPR regulations between the two cases.

MFPR REGULATION

In the following sections, the chapter provides an overview of MFPR regulations and regulatory discussions in the two countries. The data consist of legislation, constitutional litigations, government documents and official announcements by professional groups and stakeholders. Due to the difference in the regulatory structure in the field of MAR between the two countries, the weight given to different types of data in the analysis differs.

MFPR Regulation in Japan

In Japan, the incidence of multiple births increased between the 1960s and 2000s. With the implementation of IVF in clinical practice in the mid-1980s, the rate of increase further accelerated, especially of triplets and higher-order pregnancies (Imaizumi, 1995). Since its peak at 1.18 per cent in 2005, the proportion of multiple births to total deliveries has remained stable in recent years, with 1.05 per cent of all deliveries in 2020 (Ministry of Health Labour and Welfare, 2023). While there has been an organizational effort to reduce the incidence of multiple pregnancies resulting from MAR, the legal status of MFPR has not been settled, nor is there any medical guideline specifically on MFPR.

In 1986, the first case of MFPR in Japan, a reduction of quadruplets to twins, was reported by the gynaecologist Yahiro Netsu. The reported case provoked a heated debate both among physicians and in the wider public (Yomiuri Shimbun, 1987). The president of the Japan Association of Obstetricians and Gynaecologists (JAOG), the nationwide professional association, published a comment that physicians should restrain from performing MFPR until its

legality is established (Moriyama, 1988). In 1993, JAOG published a statement claiming that MFPR may violate the abortion ban. The definition of abortion in the Maternal Protection Act is “expulsion of the foetus from the mother’s body” (Article 2(2)), whereas, in the procedure of MFPR, the foetus whose development is interrupted remains in the uterus until the delivery of the other fully developed live foetus(es), later than 22 weeks. Hence, abortion of all the foetuses in multiple pregnancy by 22 weeks is legal but foetal reduction may be illegal, as the “abortion” procedure in MFPR is technically completed later than the foetal viability threshold.

With the cautious attitude against MFPR maintained in the country, the JSOG, who publishes MAR guidelines periodically, sought to prevent multiple gestations from the mid-1990s. In 1996, JSOG issued an updated guideline on IVF, setting the maximum number of embryos (three) transferred at a time.² Meanwhile, other expert organizations started to acknowledge the necessity of MFPR in the 2000s. A report in 2003 by the expert committee on MAR of the Ministry of Health Welfare and Labour stated that MFPR “may be performed if, despite precautionary measures, the number of foetuses is four or more” (Subcommittee on Assisted Reproductive Medicine, Health Science Council, 2003). In 2004, the Japan Society of Fertilization and Implantation (JSFI) also issued a statement in favour of MFPR, proposing that the definition of legal abortion in the Maternal Protection Act be amended so that it includes the extinction of a foetus *inside* the mother’s body (Japan Society of Fertilization and Implantation, 2004).

Despite these opinions, JSOG has insisted on preventing multiple gestation until the present day without solving the ambiguous legal status of MFPR. In 2008, JSOG updated the IVF guideline, reducing the maximum number of embryos transferred per cycle from three to one, except for women over 35 years old or those who have had two or more consecutive unsuccessful pregnancy attempts. The guideline also states that the infertile couple must be fully informed about the embryo cryopreservation technology, which allows for the use of surplus embryos in a later treatment cycle, so that patients do not request a treatment with higher risk of multiple pregnancy.

Yet, despite this discouragement by JAOG and JSOG, and the subsequent absence of clinical guidelines or physician’s training in MFPR, the procedure has still been practised since the late 1980s. There is limited data on the number of such procedure and their outcome in the country. One of the rare studies on the issue shows that MFPR was performed in 21.7 per cent of higher-order pregnancies between 1994 and 1996, and 33.4 per cent between 1997 and 1999 (Irahara, 2002).

In sum, the legal status of MFPR has remained ambiguous in Japan. The Japanese regulatory body for MAR, JSOG, has regarded MFPR as semi-illegal, and focused on preventing multiple gestation from the start.

Meanwhile, the procedure is performed out of necessity to higher-order pregnancies in Japanese clinics.

MFPR Regulation in Italy

In contrast to the legal vacuum in Japan, Italy legalized MFPR in 2004. Under the Italian MAR law (Law no. 40/2004), MFPR is permitted on the condition that the procedure takes place in accordance with the abortion law (Law no. 194/1978). Article 14(3) of the MAR law states that “embryo reduction in multiple pregnancies is forbidden except in cases provided for by the law no. 194 of 22 May 1978.” In other words, as long as the requirements for legal abortion are met like in singleton spontaneous pregnancy, MFPR can be performed in the case of multiple pregnancies that resulted from MAR.

This MFPR provision should be understood in the context of the legal status of embryos in the Italian MAR law. Strongly influenced by the Catholic Church’s teaching, the MAR law grants a high status to embryos, viewing the moment of conception as the beginning of human life. Article 14(1)(2) prohibits creation of more than three embryos at once, as well as suppression and cryopreservation of embryos. Furthermore, it states that all of the embryos, once created, must be transferred to the uterus at once (“sole and simultaneous implantation”). The clause that mandates the transfer of all the created embryos has widely been criticized as “unacceptable on medical grounds” by both Italian and international MAR experts, because it increases the risk of multiple pregnancy (Benagiano & Gianaroli, 2004, p. 118).

As such, under the Italian MAR law, embryo protection is prioritized over the health of the person who received the MAR procedure as well as over the ultimate goal of achieving live birth of a healthy child. However, once the pregnancy has begun, the foetus(es) may be aborted, either entirely or partly (i.e., through MFPR), as long as it is legal under the abortion law (Riezzo et al., 2016). Although there are no data that comprehensively cover the number of MFPR cases, MFPR has been included in the standard MAR protocol in Italy (Società Scientifiche SIGO-AOGOI-AGUI, 2016). This is still the case even after the Constitutional Court ruling in 2009 against the MAR law regarding the maximum limit of three embryos produced, which effectively legalized cryopreservation of embryos and thus allowed IVF treatment with a transfer of fewer than three embryos (Riezzo et al., 2016). A recent study suggests that, in Italy, even twin-to-singleton MFPR is practised, for which the clinical benefit of foetal reduction is not as established as for higher-order pregnancies (Monni et al., 2020).

DISCUSSION

The comparison of the MFPR regulations between Japan and Italy gives rise to two observations. First, the comparison between the two countries with systematic similarity on crucial contextual dimensions reveals the interactive development between medical practices and regulations in different regulatory arrangements. Specifically, I show that the regulatory structure in the field of MAR can explain the legal status of MFPR. There is a stark difference in the level of autonomy of MAR practices from legislative control between the two countries. In Japan, MAR is entirely governed by autonomous regulations, which allows rules to be generated more spontaneously, that is, medical guidelines. Because MFPR involves abortion, which is subject to a legislative regulation in Japan, developing measures to prevent multiple pregnancies is politically a less costly solution to the adverse outcome of MAR than amending the definition of induced abortion in the Maternal Protection Act. In turn, by focusing on the circumvention of multiple gestation, the relevant actors have postponed the debate on MFPR, leaving the procedure in a legal vacuum. In contrast, in Italy, MAR is regulated by strict legislation. When Law no. 40/2004 came into force in 2004, with its considerable emphasis on embryo protection, MAR practices to prevent multiple gestation, such as transfer of the minimized number of embryos per IVF cycle, were prohibited, which rendered MFPR necessary and legal. This has made MFPR a more available and less controversial option for MAR patients in Italy; even after the Constitutional Court ruling in 2009, which enabled cryopreservation of surplus embryos, MFPR has been widely practised (Monni et al., 2020).

Second, the comparative analysis of how MFPR regulations refer to abortion legislation illuminates how the respective abortion laws govern the relationship between the state, embryos/foetuses, and the pregnant person. In the Japanese case, the JAOG's hesitation towards MFPR derives from the fact that, in MFPR, the foetus that is subject to reduction physically departs from the gestating body much later than the threshold for the foetal viability. This highlights the significance of the foetal (in)viability requirement in the Japanese abortion laws. The JAOG's concern that MFPR may not fall into the definition of legal abortion does not neatly align with the typical ethical debate about the beginning of life, including the question at which point "foeticide" becomes unethical. In MFPR, interruption of the foetal development occurs in the first or early-second trimester, much earlier than when the foetus can hypothetically survive outside the uterus. However, such an ethical debate on the beginning of life is irrelevant in the Japanese abortion law; instead, the emphasis is put on when the reduced foetus(es) is discharged from the gestating body.

In the Italian case, the MFPR clause in the MAR law points to the tension between the legal protection of embryos and abortion rights of pregnant people. Although embryos are regarded as human beings following Catholic doctrine, once embryos are gestated, they become part of the pregnant person's body and thus turn into a matter of abortion rights. In other words, in Italy, embryos *in vitro* have an immediate legal status as a human, embryos *in utero* are at the pregnant person's discretion within the first 90 days of gestation. Although embryos are granted the right to life under the Italian MAR law, pregnant people's rights in the abortion law override that of the embryo once it is transplanted to the uterus. Unlike the Japanese case, the Italian abortion law does not discuss the foetal viability outside the maternal body. Instead, voluntary interruption of pregnancy, either partly or entirely, is justified on the grounds of woman's autonomy as long as it takes place within the first 90 days of gestation.

By comparatively looking at MFPR regulations in terms of how they refer to and interpret the abortion laws, it becomes clear what the abortion laws in each country are all about. The abortion ban in Japan is centred on the timing at which the aborted or reduced foetus is discharged outside of the gestating body; the expulsion of the foetus and foetal tissues has to be prior to the foetal viability threshold. Meanwhile, the Italian abortion law permits abortion within the first 90 days of gestation based on the pregnant person's right to abortion. This overrides the right of the unborn, even though the MAR law grants it the right to life from the moment of conception outside of the gestating body, that is, prior to gestation. The comparison of MFPR regulations also highlights the significance of the physical location of the foetus in relation to the gestating body along with the gestational age in the abortion regulations.

CONCLUSION

By investigating regulations and regulatory debates on multifetal pregnancy reduction (MFPR) in Italy and Japan, this chapter has explored the inter-relation between the two realms of reproduction policy, medically assisted reproduction and abortion. By comparing the country cases, the study has held two inquires. First, it has suggested that the difference in regulatory structures in the field of MAR is an explanatory factor for the divergent manifestations of the legality of MFPR in the two countries. In the Japanese case, the non-legislative organizational regulation of MAR has left the legal status of the procedure ambiguous until the present day; the gynaecologist associations have avoided the politically costly process of changing the definition of abortion in the abortion law. When it comes to dealing with the higher incidence of multiple gestation following MAR, the professional autonomy in the MAR regulatory structure has allowed gynaecologists to resort to the alternative

solution than MFPR; in the absence of legislative control on the status of embryo in vitro, the Japan Society of Obstetrics and Gynaecology was able to develop and standardize the practices to prevent multiple pregnancy in the first place. In the Italian case, the restrictive legislative regulation of MAR has limited such preventive measures and thus made MFPR legal and, paradoxically, less controversial in the country. This finding shows how medical practices and regulations develop interactively at the intersection of abortion and medically assisted reproduction.

Second, by comparing how the abortion laws are referred to and interpreted within the context of MFPR/MAR, the study has examined the focus of abortion prohibition and permission in the respective pieces of abortion legislation. On the one hand, the analysis of the MFPR regulatory debates in Japan highlights the importance of the expulsion of the foetus for interpreting the Japanese abortion laws. On the other hand, the high status of embryo in vitro in the Italian MAR legislation and the subsequent legalization of MFPR show that legal abortion in the Italian abortion law is framed as a matter of the pregnant person's autonomy as long as the embryo/foetus is in utero. The comparison has also indicated that the abortion laws in both countries put significant value on the physical location of the unborn in relation to the gestating body.

These findings provide analytical insights that are useful for comparative reproduction policy studies in two ways. First, examining more than one sub-field at the same time provides a fruitful perspective on reproduction policy as a broader regulatory domain. Instead of investigating a single reproduction policy field separately, such as abortion or MAR, we can seek to understand the links between them in order to capture how the regulator intervenes in people's reproduction more broadly by prohibiting and permitting both general and specific reproductive care procedures. Abortion and MAR are a particularly intriguing combination, because, despite the opposite reproductive outcome, both of these medical interventions are penetrated by the same legal-ethical issues. Crucially, questions of the beginning of life and the status of embryo/foetus in relation to the patient and their body are relevant for both. This means that legal and medical authorities attempt to maintain the coherence between the two policy realms. For example, regulations of MAR are not only conditioned by the preceding abortion laws, but may also be a useful tool for understanding the logics of abortion regulations more deeply.

Second, the findings of this chapter demonstrate the advantage of a cross-country comparison in the field of reproduction policy. Because reproductive health services involve ethical-legal issues, regulations on these services are embedded in the specific socio-cultural contexts. Even for the purpose of delving into a single country case, such specificity can be captured better with a comparative reference to other cases. This chapter shows how comparative analysis offers insights into, for example, how medicine and

policy interact with each other in the field of reproduction, and how different sub-fields of reproduction policy affect each other.

It is crucial to note that medical practices and technologies develop in interaction with relevant regulations. Such development plays out differently across contexts especially in the field of reproduction, because reproduction policy that conditions medical practices reflects the cultural and ethical understanding assigned to reproduction in a specific society.

NOTES

1. Under the Maternal Protection Act, the exact pregnancy week of foetal viability is determined by a ministerial decree. It has been moved forward according to the development of premature infant care. It is currently 23 weeks, which means abortion is legal up to 22 weeks and 6 days.
2. Around the same time, the cryopreservation technique was improved (Kasai, 1997). In 1995, the vitrification method was developed in Japan which significantly increased the survival rate of human embryo cryopreserved because, in contrast to the preceding slow-freezing procedure, it prevents the ice formation which causes physical and chemical injuries to the cell (Rezazadeh Valojerdi et al., 2009).

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