

## Observational Study

## Effect of intraoperative cell rescue on bleeding related indexes after cesarean section

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## Abstract

## BACKGROUND

Obstetric hemorrhage is the leading cause of maternal mortality globally, especially in China. The key to a successful rescue is immediate and rapid blood transfusion. Autotransfusion has become an integral part of clinical blood transfusion, with intraoperative cell salvage (IOCS) being the most widely used.

## AIM

To investigate the application of IOCS in cesarean section.

## METHODS

A total of 87 patients who underwent cesarean section and blood transfusion in our hospital from March 2015 to June 2020 were included in this prospective controlled study. They were divided into the observation (43 cases) and control (44 cases) groups using the random number table method. The patients in both groups underwent lower-segment cesarean section. The patients in the control group were treated with traditional allogeneic blood transfusion, whereas those in the observation group were treated with IOCS. Hemorheology [Red blood cell count, platelet volume, and fibrinogen (FIB)] and coagulation function (partial prothrombin time, prothrombin time (PT), platelet count, and activated coagulation time) were measured before and 24 h after transfusion. In the two groups, adverse reactions, such as choking and dyspnea, within 2 h after cesarean section were observed.

## RESULTS

Before and after transfusion, no significant differences in hemorheology and coagulation function indices between the two groups were observed ( $P > 0.05$ ). About 24 h after transfusion, the erythrocyte count, platelet ratio, and FIB value

significantly decreased in the two groups ( $P < 0.05$ ); the PLT value significantly decreased in the two groups; the activated partial thromboplastin time, PT, and activated clotting time significantly increased in the two groups ( $P < 0.05$ ); and no statistical differences were observed in hemorheology and coagulation function indices between the two groups ( $P > 0.05$ ). Furthermore, there was no significant difference in the incidence of adverse reactions between the two groups ( $P > 0.05$ ).

### CONCLUSION

In patients undergoing cesarean section, intraoperative cell salvage has a minimum effect on hemorheology and coagulation function and does not increase the risk of amniotic fluid embolism.

**Key Words:** Intraoperative cell salvage; Cesarean section; Amniotic fluid embolism; Hemorheology; Coagulation function

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**Core Tip:** A total of 87 patients who underwent cesarean section and blood transfusion in our hospital from March 2015 to June 2020 were included in this prospective controlled study. The patients were divided into the observation (43 cases) and control (44 cases) groups using the random number table method. Intraoperative cell salvage (IOCS) was found to have a minimum effect on hemorheology and coagulation function in patients with cesarean section and does not increase the risk of amniotic fluid embolism. These findings indicate that the principle of IOCS should be strictly followed during operation, which is worth promoting.

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## INTRODUCTION

Obstetric hemorrhage is the leading cause of maternal mortality globally, accounting for 27.1% of all maternal deaths[1,2]. It has also been recently reported to be the leading cause of death among pregnant women in China. With the liberalization of China's birth policy, there are more and more elderly pregnant women, and their risk of postpartum hemorrhage increases accordingly[3]. The key to a successful rescue is immediate and rapid blood transfusion; however, traditional allogeneic blood transfusion involves safety problems, including blood shortage, transfusion-related infection, and immune suppression[4,5], which poses great safety risks to puerpera and babies. In recent years, with the development of the blood transfusion concept and the maturity of blood transfusion technology, autotransfusion has become an integral part of clinical blood transfusion. In addition, it has attracted a considerable amount of attention owing to its ability to effectively relieve the increasingly tight blood supply and prevent the occurrence of homoimmune reaction and disease transmission[6]. According to different sources, autologous blood transfusion is divided into storage type of autologous blood transfusion which was to store your own blood in advance for use when you need it in the future, diluted autotransfusion which was collected and preserved before operation and diluted with plasma substitutes, and intraoperative cell salvage (IOCS), with the latter being the most widely used. In IOCS, the blood recovery device is used to recover, anticoagulate and filter the intraoperative blood loss and postoperative bleeding. Then, the blood is reinfused to the patient. IOCS is also widely used in orthopedics, cardiothoracic surgery, *etc.*[7-9]. However, due to the limitations of traditional technology, the application of IOCS in obstetrics was previously believed to increase the risk of amniotic fluid embolism. In recent years, with the advancement of technology, blood recovery devices and leukocyte filters can effectively eliminate the risk factors of amniotic fluid embolism[10-12]. Therefore, the use of IOCS in cesarean section has been given a considerable amount of attention. In this paper, the application of IOCS in cesarean section, monitoring of amniotic fluid embolization, and other related indications are discussed, demonstrating its safety in cesarean section.

## MATERIALS AND METHODS

### General information

A total of 87 patients who underwent cesarean section and blood transfusion in our hospital from March 2015 to June 2020 were included in this prospective controlled study. The patients were divided into the observation and control groups using the random number table method. The observation group consists of 43 patients (age, 23 to 50 years; average age,  $35.21 \pm 7.85$  years; body mass index,  $19\text{--}26$  kg/m<sup>2</sup>; average body mass index,  $22.57 \pm 2.25$  kg/m<sup>2</sup>; and gestational age,  $37.2 \pm 1.3$  wk). In this group, there were 29 and 14 primiparas and multiparas, respectively. Conversely, the control group consisted of 44 patients (age, 22 to 50 years; average age,  $34.64 \pm 8.02$  years; body mass index,  $18\text{--}27$  kg/m<sup>2</sup>; average body mass index,  $22.39 \pm 2.82$  kg/m<sup>2</sup>; and gestational age,  $37.2 \pm 1.2$  wk). In this group, there were 26 and 18 primiparas and paras, respectively. No significant difference was observed in the general clinical data between the two groups ( $P > 0.05$ ), thus indicating clinical comparability. This study was approved by the ethics committee of our hospital, and signed informed consent was obtained from all the parturients and/or their families.

### Inclusion and exclusion criteria

The inclusion criteria were meeting the conditions of cesarean section, American Society of Anesthesiologists Grades II-III, stable physical signs and clear consciousness, and normal preoperative blood system, heart, liver, and kidney.

The exclusion criteria were the presence of pregnancy complications such as cardiovascular and immune system diseases, made worse by malignant tumor, and expected anticoagulant treatment before operation. Cognitive and mental disorders, the contraindications to blood transfusion, and participation in other clinical studies during pregnancy.

### Methods of operation and postoperative blood transfusion

The patients in both groups underwent lower-segment cesarean section. The patients in the control group were treated with traditional allogeneic blood transfusion, whereas those in the observation group were treated with IOCS.

### Anesthesia

Routine oxygen mask inhalation and continuous monitoring of electrocardiogram, respiration, and other vital signs were performed. L<sub>3-4</sub> lumbar anesthesia combined with epidural anesthesia were performed, and 1% ropivacaine was diluted with cerebrospinal fluid and injected into the subarachnoid space. The lumbar anesthesia and puncture needles were removed, and an epidural catheter was fixed to control the anesthesia block level to T6. If the parturient women have intraspinal anesthesia taboo syndrome, they shall be induced in a rapid sequence and then subjected to endotracheal intubation general anesthesia. If the heart rate is  $\leq 55$  beats/min and the systolic blood pressure is  $\leq 80$  mmHg, ephedrine and atropine should be administered, respectively.

### Intraoperative cell salvage

The amount of blood loss was measured using the volume method combined with the weighing method. The Cell saver type five blood recovery system (American Blood Technology Company) was used. Before surgery, pipes, blood storage tanks, blood storage bags, *etc.* were installed. The recovery system was pre-washed with 200 mL of normal saline containing 50000 U of heparin sodium, and the blood recovery system turned on 10 min before surgery. After the amniotic fluid was exhausted and the fetus was delivered, the blood in the surgical field was sucked into the blood storage tank using a negative-pressure suction device. Mix the blood with 50 U/mL heparin sodium normal saline in a volume ratio of 1:5, filter, wash, separate and clean it, and then enter the circulation tank. Based on the condition of the patient, transfusion was performed through a white blood cell filter, and the vital signs and adverse reactions of the patient were closely monitored during the process.

### Blood transfusion indications

The indications for allogeneic transfusion were as follows: the red blood cells (RBCs) were transfused when the hemoglobin level was  $< 80$  g/L and/or the RBC ratio was  $< 0.21$ ; fresh frozen plasma was transfused when the prothrombin time (PT) and activated partial thromboplastin time (APTT) were  $> 1.5$  times the reference value and the international standardized ratio was  $> 1.5$ ; and the platelet was transfused when the platelet count was less than  $50 \times 10^9/L$ .

The indications for autologous blood transfusion were as follows[13,14]: the amount of blood loss was less than 20% of the body blood volume, and autologous blood was transfused after abdominal closure; the amount of blood loss was  $\geq 20\%$  of the total body blood volume; autologous blood was immediately infused; and allogeneic blood was infused when the patient's vital signs could not be maintained after intraoperative autologous blood transfusion.

### **Observation indicators and evaluation criteria**

**Hemorheology:** 2 mL of femoral vein blood was collected from the patients before and 24 h after transfusion, and ethylenediaminetetraacetic acid anticoagulation was employed to detect the RBC count, platelet volume, and fibrinogen (FIB) value (FIB normal value: 2.4–3.7 g/L).

**Blood coagulation function:** Before and 24 h after blood transfusion, 2 mL of fasting venous blood was collected from the patients' forearm in the morning and then centrifuged at 3000 r/min for 10 min to separate the plasma. The APTT, PT, PLT, and activated clotting time (ACT) values were determined using an automatic hemagglutination instrument.

**Adverse reactions:** Adverse reactions such as choking, dyspnea, vomiting, postpartum hemorrhage, and shock within 2 h after cesarean section were observed in the two groups.

### **Statistical analysis**

SPSS version 22.0 was used for the data analysis. The data were expressed as mean  $\pm$  SE of the mean, and *t*-test was employed. Count data were expressed as case (%), and a  $\chi^2$  test was employed.  $P < 0.05$  was considered statistically significant.

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## **RESULTS**

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### **Comparison of hemorheology between the two groups**

No significant differences were observed in the RBC count, platelet volume, and FIB value between the two groups before and after transfusion ( $P > 0.05$ ). About 24 h after transfusion, the erythrocyte count, platelet volume, and FIB value significantly decreased ( $P < 0.05$ ) in both groups, and no statistical difference was observed between the two groups ( $P > 0.05$ ) (Table 1).

### **Comparison of the coagulation function between the two groups**

No significant differences in the APTT, PT, PLT, and ACT values were observed between the two groups after transfusion ( $P > 0.05$ ). About 24 h after transfusion, the PLT value significantly decrease; the APTT, PT, and ACT significantly increased ( $P < 0.05$ ), and no statistical significance was observed between the two groups ( $P > 0.05$ ) (Table 2).

### **Comparison of adverse reactions between the two groups**

No significant difference was observed in the incidence of adverse reactions between the two groups ( $P > 0.05$ ) (Table 3).

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## **DISCUSSION**

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The entry of the amniotic fluid substance to the maternal blood circulation during delivery can cause amniotic fluid embolism, which manifests as disseminated intravascular coagulation, shock, acute pulmonary embolism, *etc.* They pose a serious threat to maternal safety. In addition, autotransfusion is thought to increase the risk of amniotic fluid embolism in women undergoing cesarean section. In this study, the safety of IOCS in cesarean section was investigated. Our results indicated no significant changes in hemorheology and the coagulation function of parturients when IOCS was employed compared with that when traditional allogeneic transfusion was employed ( $P > 0.05$ ). Along with the pathogenesis of amniotic fluid embolism, (1) Fetal substances contained in the amniotic fluid block the microorgans of various maternal organs, and (2) Maternal allergic reaction to fetal components in the amniotic fluid causes pulmonary vasoconstriction, platelet and white blood cell excitation, and activation of complement components, which are highly likely to cause amniotic fluid embolism[15,16].

The results of this study indicate that IOCS does not increase the risk of maternal amniotic fluid embolism. The reason may be that the circulating blood recovery device for autologous blood transfusion can deal with body cavity bleeding, intraoperative blood loss and postoperative drained blood through circulation, anticoagulation, filtration and washing. At the same time, the technology can wash platelets, tissues, blood, anticoagulants and plasma proteins as much as possible, reduce platelet count and improve coagulation function[17].

Furthermore, alpha-fetoprotein, phosphatidylglycerol, fetal squamous epithelial cells, and some inflammatory factors can be entirely removed from the blood to reduce the risk of amniotic fluid embolism[18].

In clinical practice, IOCS has the following advantages[19-21]: (1) It can relieve the increasingly tight blood supply and does not require blood type identification and cross-matching, which is convenient and safe; and (2) It can prevent the spread of infectious diseases and adverse reactions caused by allogeneic blood transfusion. If IOCS has high operational requirements, the collection and transfusion

Table 1 Comparison of the hemorheology indices between the two groups

Group	n	Red blood cell count ( $\times 10^{12}/L$ )				Platelet volume (%)				FIB (g/L)			
		Before transfusion	After transfusion	t	P value	Before transfusion	After transfusion	t	P value	Before transfusion	After transfusion	t	P value
Control	44	4.35 $\pm$ 0.62	3.56 $\pm$ 0.55	6.323	< 0.001	0.51 $\pm$ 0.17	0.40 $\pm$ 0.10	3.7	< 0.001	3.32 $\pm$ 0.50	2.31 $\pm$ 0.41	10.361	< 0.001
Observation	43	4.19 $\pm$ 0.53	3.45 $\pm$ 0.55	6.353	< 0.001	0.55 $\pm$ 0.14	0.38 $\pm$ 0.08	6.913	< 0.001	3.28 $\pm$ 0.53	2.27 $\pm$ 0.36	10.337	< 0.001
t		1.292	0.933			1.197	1.029			0.362	0.483		
P value		0.1997	0.354			0.235	0.307			0.718	0.63		

FIB: Fibrinogen.

Table 2 Comparison of the coagulation function indices between the two groups

Group	n	APTT (s)				PT (s)				PLT ( $\times 10^9/L$ )				ACT (s)			
		Before transfusion	After transfusion	t	P value	Before transfusion	After transfusion	t	P value	Before transfusion	After transfusion	t	P value	Before transfusion	After transfusion	t	P value
Control	44	34.75 $\pm$ 2.95	42.65 $\pm$ 6.78	7.087	< 0.001	14.15 $\pm$ 3.41	18.02 $\pm$ 5.35	4.046	< 0.001	212.35 $\pm$ 35.15	166.57 $\pm$ 26.17	6.93	< 0.001	91.21 $\pm$ 15.75	124.14 $\pm$ 23.12	7.808	< 0.001
Observation	43	35.25 $\pm$ 3.06	40.67 $\pm$ 5.21	5.882	< 0.001	14.45 $\pm$ 3.26	18.35 $\pm$ 4.85	4.376	< 0.001	219.45 $\pm$ 32.16	168.54 $\pm$ 29.35	7.668	< 0.001	90.75 $\pm$ 16.54	121.76 $\pm$ 25.37	6.714	< 0.001
t		0.776	1.536			0.419	0.301			0.982	0.331			0.133	0.458		
P value		0.44	0.128			0.676	0.764			0.329	0.742			0.895	0.649		

APTT: Activated partial thromboplastin time; PT: Prothrombin time; ACT: Activated clotting time.

of blood should follow the principles of aseptic operation to reduce the risk of cross-infection. To prevent excessive negative pressure resulting in the formation of excessive blood foam, which causes hemolysis and destruction of RBC, the suction pressure should be controlled below 20 kPa during blood recovery.

This study has certain limitations, including the relatively small sample size, which may be insufficient to evaluate the overall differences in the use of the two transfusion methods. Another limitation is the cross-sectional design of this study, which could only infer an association, not a cause. Thus, more studies in the future are needed to confirm the effect of intraoperative cell rescue on cesarean hemorrhage.

Table 3 Comparison of adverse reactions between the two groups

Group	n	Choking	Dyspnea	Restless	Vomiting	Shock	cyanosis	Postpartum hemorrhage	Total
Control	44	1	1	1	0	0	2	0	5
Observation	43	1	0	2	1	0	1	1	6

## CONCLUSION

In summary, IOCS has a negligible effect on hemorheology and the coagulation function in patients with cesarean section and does not increase the risk of amniotic fluid embolism. However, the principle of IOCS should be strictly followed during operation, which is worth promoting.

## ARTICLE HIGHLIGHTS

### Research background

Obstetric hemorrhage is the leading cause of maternal mortality globally, especially in China. The key to a successful rescue is immediate and rapid blood transfusion. Autotransfusion has become an integral part of clinical blood transfusion, with intraoperative cell salvage (IOCS) being the most widely used.

### Research motivation

In this paper, the application of IOCS in cesarean section, monitoring of amniotic fluid embolization, and other related indications are discussed, demonstrating its safety in cesarean section.

### Research objectives

This study aimed to investigate the application of IOCS in cesarean section.

### Research methods

A total of 87 patients who underwent cesarean section and blood transfusion in our hospital from March 2015 to June 2020 were enrolled in this prospective controlled study.

### Research results

Before and after transfusion, no significant differences were observed in hemorheology and the coagulation function indices between the two groups. About 24 h after transfusion, the erythrocyte count, platelet ratio, and fibrinogen value significantly decreased in the two groups; the PLT value significantly decreased in the two groups; the activated partial thromboplastin time, prothrombin time, and activated clotting time significantly increased in the two groups; and no statistical differences were observed in the hemorheology and coagulation function indices between the two groups. Furthermore, there was no significant difference in the incidence of adverse reactions between the two groups.

### Research conclusions

IOCS has a negligible effect on hemorheology and coagulation function in patients undergoing cesarean section and does not increase the risk of amniotic fluid embolism.

### Research perspectives

The principle of IOCS should be strictly followed during operation, which is worth promoting.

## FOOTNOTES

**Author contributions:** Yu YF wrote the manuscript; Cao YD participated in data analysis.

**Institutional review board statement:** The study was approved by the Ethics Committee of Hai'an People's Hospital Affiliated to Nantong University.

**Informed consent statement:** All patients gave informed consent.

**Conflict-of-interest statement:** No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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## REFERENCES

- 1 **Say L**, Chou D, Gemmill A, Tunçalp Ö, Moller AB, Daniels J, Gülmezoglu AM, Temmerman M, Alkema L. Global causes of maternal death: a WHO systematic analysis. *Lancet Glob Health* 2014; **2**: e323-e333 [PMID: 25103301 DOI: 10.1016/S2214-109X(14)70227-X]
- 2 **Nathan LM**. An overview of obstetric hemorrhage. *Semin Perinatol* 2019; **43**: 2-4 [PMID: 30691692 DOI: 10.1053/j.semperi.2018.11.001]
- 3 **Chen L**, Feng P, Shaver L, Wang Z. Maternal mortality ratio in China from 1990 to 2019: trends, causes and correlations. *BMC Public Health* 2021; **21**: 1536 [PMID: 34380436 DOI: 10.1186/s12889-021-11557-3]
- 4 **O'Brien KL**, Shainker SA, Lockhart EL. Transfusion Management of Obstetric Hemorrhage. *Transfus Med Rev* 2018; **32**: 249-255 [PMID: 29934136 DOI: 10.1016/j.tmr.2018.05.003]
- 5 **Lei B**, Wang L, He J, Wang Y, Li Y. Clinical application of intraoperative salvage autotransfusion in cesarean section with high blood risk. *Shanxi Yiyao Zazhi* 2021; **50**: 1241-1245 [DOI: 10.3969/j.issn.0253-9926.2021.08.003]
- 6 **Wang C**, Zhang X. Current status of clinical application of autotransfusion. *Linchuang Xueyexue Zazhi* 2019; **32**: 319-321 [DOI: 10.13201/j.issn.1004-2806-b.2019.04.023]
- 7 **Lim G**, Melnyk V, Facco FL, Waters JH, Smith KJ. Cost-effectiveness Analysis of Intraoperative Cell Salvage for Obstetric Hemorrhage. *Anesthesiology* 2018; **128**: 328-337 [PMID: 29194062 DOI: 10.1097/ALN.0000000000001981]
- 8 **Liu Y**, Li X, Che X, Zhao G, Xu M. Intraoperative cell salvage for obstetrics: a prospective randomized controlled clinical trial. *BMC Pregnancy Childbirth* 2020; **20**: 452 [PMID: 32767971 DOI: 10.1186/s12884-020-03138-w]
- 9 **Kumar N**, Ravikumar N, Tan JYH, Akbary K, Patel RS, Kannan R. Current Status of the Use of Salvaged Blood in Metastatic Spine Tumour Surgery. *Neurospine* 2018; **15**: 206-215 [PMID: 30071572 DOI: 10.14245/ns.1836140.070]
- 10 **Yao Y**, Li J, Wang M, Chen Z, Wang W, Lei L, Huang C, Yao M, Yuan G, Yan M. Improvements in blood transfusion management: cross-sectional data analysis from nine hospitals in Zhejiang, China. *BMC Health Serv Res* 2018; **18**: 856 [PMID: 30428874 DOI: 10.1186/s12913-018-3673-x]
- 11 **O'Flaherty D**, Enright S, Ainle FN, Hayes N. Intraoperative cell salvage as part of a blood conservation strategy in an obstetric population with abnormal placentation at a large Irish tertiary referral centre: an observational study. *Ir J Med Sci* 2020; **189**: 1053-1060 [PMID: 32002738 DOI: 10.1007/s11845-020-02182-x]
- 12 **Grainger H**, Catling S. Intraoperative cell salvage in obstetrics. *J Perioper Pract* 2018; **28**: 51-58 [PMID: 29493387 DOI: 10.1177/1750458918755960]
- 13 **Waters JH**, Biscotti C, Potter PS, Phillipson E. Amniotic fluid removal during cell salvage in the cesarean section patient. *Anesthesiology* 2000; **92**: 1531-1536 [PMID: 10839901 DOI: 10.1097/0000542-200006000-00008]
- 14 **Guo Y**. Recommendations and implications of the British Series of guidelines for the management of maternal Bleeding (I) - Guidelines for Obstetric Blood Transfusion. *Zhongguo Shuxue Zazhi* 2016; **29**: 113-121 [DOI: 10.13303/j.cjbt.issn.1004-549x.2016.10.042]
- 15 **Zhang W**. Chinese Perinatal Medicine. Beijing: People's Medical Publishing House, 2012: 655
- 16 **Tamura N**, Farhana M, Oda T, Itoh H, Kanayama N. Amniotic fluid embolism: Pathophysiology from the perspective of pathology. *J Obstet Gynaecol Res* 2017; **43**: 627-632 [PMID: 28188959 DOI: 10.1111/jog.13284]
- 17 **Shamshirsaz AA**, Clark SL. Amniotic Fluid Embolism. *Obstet Gynecol Clin North Am* 2016; **43**: 779-790 [PMID: 27816160 DOI: 10.1016/j.ogc.2016.07.001]
- 18 **Liao X**, Fang JL. The effect of retrievable autotransfusion on hemorheology and coagulation function of obstetric surgery patients. *Mazui Yu Tengong* 2021; **59**: 130-133
- 19 **Seyfried TF**, Streithoff F, Gruber M, Unterbuchner C, Zech N, Kieninger M, Hansen E. Platelet sequestration with a new-generation autotransfusion device. *Transfusion* 2018; **58**: 989-997 [PMID: 29380387 DOI: 10.1111/trf.14491]
- 20 **Petryk N**, Petryk M. Ovarian Rejuvenation Through Platelet-Rich Autologous Plasma (PRP)-a Chance to Have a Baby Without Donor Eggs, Improving the Life Quality of Women Suffering from Early Menopause Without Synthetic Hormonal Treatment. *Reprod Sci* 2020; **27**: 1975-1982 [PMID: 32700285 DOI: 10.1007/s43032-020-00266-8]

- 21 **Wang R**, Luo T, Liu Z, Fan J, Zhou G, Wu A, Liu J. Intraoperative cell salvage is associated with reduced allogeneic blood requirements and has no significant impairment on coagulation function in patients undergoing cesarean delivery: a retrospective study. *Arch Gynecol Obstet* 2020; **301**: 1173-1180 [PMID: [32248298](#) DOI: [10.1007/s00404-020-05500-x](#)]





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