

# A comprehensive comparison of the early and late complications of surgical circumcision in neonates and children: A cohort study

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## Abstract

**Background and Aims:** Major circumcision complications are rare; however, circumcision arouses distress in some special cases. The present study aimed to compare infancy and childhood regarding the frequency and relative risk of early and late complications of circumcision.

**Methods:** This study was a retrospective cohort data analysis including 240 neonates and 240 children referred for circumcision from 2015 to 2021. All circumcisions were performed using the surgical dorsal-ventral slits method. A Cox proportional hazard model was used to assess the relative risk (RR) of complications at a confidence Interval of 95%.

**Results:** The mean age was  $19.32 \pm 6.5$  days for the neonates and  $46.1 \pm 8.8$  months for the children. In general, complications occurred in 61 boys (12.7%), 40 neonates (8.3%), and 21 children (4.4%) ( $p < 0.001$ ). Bleeding was the most common early complication in six neonates (2.5%) and three children (1.3%), and meatal stenosis was the most common late complication in 10 neonates (4.2%) and four children (1.6%). Meatal web was observed in 11 neonates (4.6%) and four children (1.6%), and the incomplete removal of the prepuce, as “not very satisfactory”, was also noticed in nine neonates (3.75%) and three children (1.3%). The circumcision complications were significantly more frequent in neonates than in children (RR = 2.6, 95% CI 1.46–4.71,  $p < 0.001$ ). The neonatal circumcisions had a significant risk of the incomplete removal of the prepuce, meatal web, and meatal stenosis compared to children (RR = 3, 95% CI 5.83–10.81,  $p < 0.04$ ; RR = 2.75, 95% CI 0.9–8.3,  $p < 0.03$ ; RR = 2.5, 95% CI 0.8–7.75,  $p < 0.04$ , respectively).

**Conclusion:** The risk of complications is higher in neonates than children. The incomplete removal of prepuce, meatal web, and meatal stenosis are significantly higher in neonates than in children. Before prohibiting or recommending this procedure, practitioners should provide comprehensive information about its risks and benefits. Parents should weigh up the risks and benefits and make the best decision regarding their personal beliefs and customs.

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## KEYWORDS

children, circumcision, complications, meatal stenosis, neonates

## 1 | INTRODUCTION

The history of circumcision dates back to 2300 BC, when it was first noticed in Egypt. Circumcision in children and infants is one of the most common surgeries worldwide.<sup>1</sup> Globally, approximately 30% of men are circumcised.<sup>2</sup> The most common indication of circumcision is social and ritual. Furthermore, some authors have hypothesized that it may prevent sexually transmitted diseases (STDs).<sup>3,4</sup>

A recent systematic review claimed that the overall benefit to the risk of circumcision is 200:1 to 100:1. The complications of circumcision are often minor and can be easily controlled. Its major complications are rare; however, in some special cases, it arouses distress in parents, children, and the performer, especially if another surgery is necessary. Most children with major complications need revised surgery. The main factors leading to complications are age, lack of sterility, improper cauterization, and inexperienced circumcisers.<sup>5,6</sup>

The total complication rate of circumcision is 0%–16% (1.5%). The main early and late complications of circumcision are bleeding, glans injury, infection, adhesion, excessive foreskin removal, meatal stenosis and phimosis, and false micropenis (inconspicuous penis).<sup>7,8</sup> Neonatal circumcision has rapid healing, a lower complication rate,

and less cost. The complication rate of neonatal circumcision is 1.5%, and the rate in older boys is 2.9%.<sup>9</sup> A comprehensive review study revealed that the complication rate was 0.4% in infants and 10–20 folds higher in non-infant circumcision.<sup>10</sup> Conversely, a study concluded that the complications of circumcision were more frequent in infants than in children.<sup>11</sup> There is a controversy about the complication rates of neonatal and early childhood circumcision. Some studies have indicated that complications are less frequent in infancy than in childhood; however, some other studies have reached different results. They showed that the complications of circumcision in childhood are less frequent than or equal to those in infancy (Table 1). However, the outcomes of circumcision are underreported. In other words, circumcision has some side-effects not well-explained in the current era. The rate of complications of circumcision seems to be higher than the one previously reported.<sup>12</sup> Furthermore, most studies have examined a limited number of complications. There is no comprehensive survey of early and late complications in infancy, especially in childhood. In our practice, the rates of circumcision complications were not higher in childhood than in neonates. This study intended to provide circumcisers with deeper knowledge about the adverse effects of circumcision to guide their relevant clinical performance and parental counseling.

**TABLE 1** The frequency of complications in neonatal and older boys' circumcision\*

Author	Country	Year	Number	Age	Frequency of complications
Aldemir <sup>15</sup>	Turkey	2006	200	2–6 years	5%
Al-marhoon <sup>15</sup>	Oman	1997–2000	171	Neonatal	1.2%
Bazmamoun <sup>15</sup>	Iran	2006–2007	394	Mean 9 months	7–10%
Bcheraoui <sup>10</sup>	USA	2001–2010	1.4 million	Early infant Older boys	0.4% infants 10–20 fold in older boys
Erglo <sup>15</sup>	Turkey	2001–2002	214	Neonatal	2.3%
Hung <sup>9</sup>	USA	2005–2010	24432	Neonatal Non-neonatal (<5 years)	1.5% neonatal 2.2% non-neonatal
Iftikhar <sup>15</sup>	Pakistan	1998–2001	318	0–12 years	0.6%
Ketabchi <sup>11</sup>	Iran	2010–2013	120	Neonatal children	27.27% in children 2–3 fold in neonates
Moosa <sup>18</sup>	Pakistan	2016–2018	2822	1–90 days	Minor events 3.8% Major events 0.3%
Schmitz <sup>15</sup>	Malaysia	2001	64	Median 10 years	1.6%
Sharma <sup>15</sup>	India	2003	15	2–25 years	13.3%
Rafiq <sup>15</sup>	Pakistan	2000	100	Neonatal	2%

\*From: references 9–11, 15 and 18.

This study aimed to evaluate the early and late complications of surgical circumcision in neonates and childhood and compare the frequency and relative risk of complications between two age groups.

## 2 | PATIENTS AND METHODS

### 2.1 | Study setting and design

This study was a retrospective cohort conducted in two tertiary primary care hospitals in Tehran, Iran, from November 2015 to April 2021.

### 2.2 | Participants

Two hundred forty neonates and 240 boys aged 3–5 years, who referred for circumcision, were included in the study. Inclusion criteria were healthy boy neonates and 3–5-year-old boy children with no external genitalia anomaly, whose parents requested religious and ritual circumcision. Exclusion criteria were meatal stenosis, bleeding disorders, hypospadias, phimosis, prepuce inflammation, glans lichen sclerosis, dermatologic disturbances, and concealed penis. According to Ketabghi et al.<sup>11</sup> and the G-Power software using the following sample size formula 
$$n_1 = n_2 = \frac{(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2 [P_1(1-P_1) + P_2(1-P_2)]}{(P_1 - P_2)^2}$$
 at a confidence level of 95% and  $\alpha = 0.05$ ;  $\beta = 0.2$ ;  $P_1 = 5\%$ ;  $P_2 = 20\%$ ;  $Z_{1-\frac{\alpha}{2}} = 1.96$ ;  $Z_{1-\beta} = 0.84$ , and power 80%, the sample size per group was calculated to be 200 subjects. With a 20% drop-out, 240 subjects were included in each group. During the research, there was no drop-out. Finally, 440 patients completed the study and were analyzed (Figure 1). A single academic urologist performed all circumcisions. The surgeries were done in a sterile situation using the surgical dorsal-ventral slits method without a cautery device. The patient was placed supine, with the legs astride to expose the penis. The penis and pelvic area were prepped with povidone-iodine and draped with a sterile sheet. All babies and most children were circumcised with local anesthesia; however, only some children needed general anesthesia, according to the opinion of the anesthesiologist because of the child's anxiety and non-cooperation in the operating room. The light general anesthesia was performed with 1 mg/kg ketamine injection without muscle relaxants. Dorsal nerve was blocked five minutes before the surgery by lidocaine 1% without epinephrine. The dorsal penile nerve block was performed by 0.8 mL injection circumferentially or by 0.2–0.4 mL injections at 10 and 2 o'clock at the base of the penis. A curved hemostat was used to separate the adhesions on the glans. Then prepuce was everted, the smegma was cleaned, and any adhesion was lysed. The prepuce was unattached right to the corona. A circumferential incision was made on the inner prepuce, 0.25–0.5 cm proximal to the corona. The prepuce was returned over the glans. Then two straight hemostats were implemented to the distal end of

the foreskin at 10 and 2 o'clock. A circumferential incision was performed over the prepuce proximal to the corona with slight traction on the prepuce. Dorsal and ventral slits were done on the prepuce down to the penile skin mark. The prepuce was resected, the bleeding vessels were ligated, starting with the frenular artery, and homeostasis was secured. Finally, the penile skin was sutured to the coronal by a 5/0 chromic catgut. A vaseline gauze dressing was placed around the suture line. The dressing was removed at home after 48 h. All boys were evaluated on the first day, 5th day, and 3 months after the surgery to record any complication. All postsurgical complications were defined and compared between the two age groups.

### 2.3 | Early and late complications

Early complications were bleeding, urinary retention, infection, inflammation, glans amputation, glans necrosis, hematoma, and the excessive removal of the foreskin. Late complications were meatal stenosis, chordee, skin adhesion to glans, fistula, inclusion cyst, penile rotation, and trapped penis. Late complications were determined as those emerged after 3 months. Incomplete removal of prepuce and meatal web were not complications and were defined as "not very satisfactory" regarding the parent's perception of circumcision appearance.

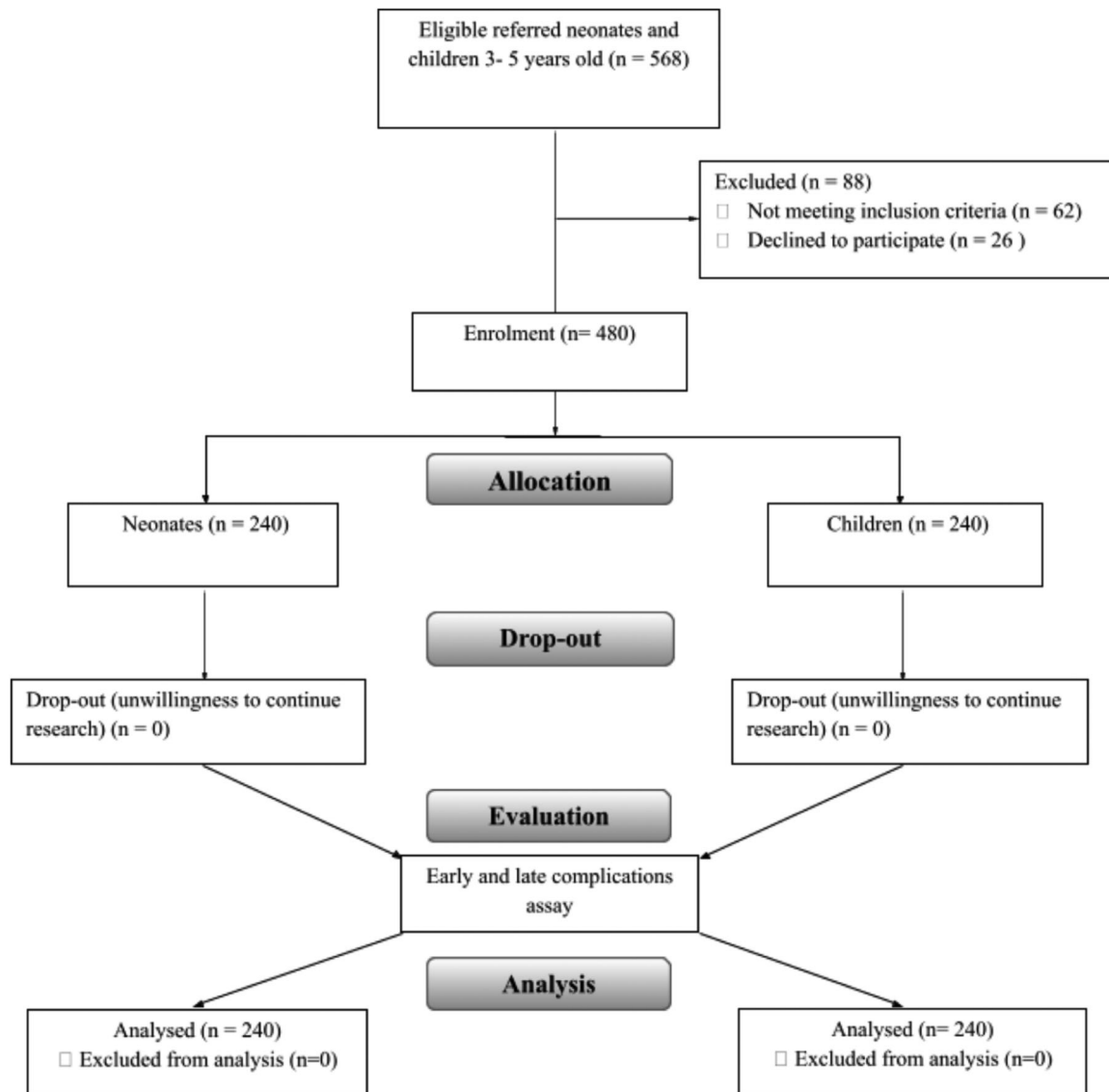
Bleeding that needed to return for surgical control was considered significant and reported. Meatal stenosis was defined as the loss of the elliptical shape of the meatus to a circular shape due to scarring, which was determined by meatal examination in the form of the visual pinpoint narrowing of the urethral meatus. Meatal web was defined based on observing the delicate and soft web at the ventral surface of the urethral meatus.<sup>13</sup>

### 2.4 | Main outcome measures

The participants' basic characteristics and their early and late complications were recorded. Furthermore, the relative risks (RR) of the complications were compared as the main outcome between the two age groups at a confidence interval of 95%.

### 2.5 | Statistical analysis

Categorical variables were represented by frequency and frequency percentages, and mean, and standard deviation were used for the continuous variables. The Chi-square test (or Fisher's exact tests for cells with <5 data) was utilized to analyze the complications of circumcision in the two age groups. A Cox proportional hazard model was used to assess the RR of complications at the confidence interval of 95%. SPSS software version 21 (IBM SPSS Inc.) was used, and  $p < 0.05$  was set as the significance level.



**FIGURE 1** Flow diagram of the study.

## 2.6 | Ethical approval

Informed consent was obtained from the parents. The participants' information was kept confidential. The Research Ethics Committee of the Aja University of Medical Sciences confirmed the study project (Code: IR.AJAUMS.REC.1400.186).

## 3 | RESULTS

In this research, 240 neonates and 240 boys were analyzed. The mean age of neonates was  $19.32 \pm 6.5$  days, and older boys' mean age was  $46.1 \pm 8.8$  months (Table 2). This study revealed complications in 61 boys (12.7%), 40 neonates (8.3%), and 21 children (4.4%) ( $p < 0.001$ ). In general, the neonates had a higher risk of complications than children (RR = 2.6, 95% CI 1.46–4.71,  $p < 0.001$ ). Early

complications developed in 26 participants (5.4%), and late complications were observed in 35 subjects (7.3%). Bleeding was the most common early complication in nine cases (1.9%), and meatal stenosis was the most common late complication in 14 cases (2.9%). Meatal web and incomplete removal of prepuce were observed in 15 (3.1%) and 12 (2.5%) cases, respectively. Table 3 shows the other complications.

According to the participants' age, accumulative complication rates are shown in Table 4. Among the 240 neonates, complications occurred in 40 cases (16.7%), of which 6.7% ( $n = 16$ ) were early, and 10% ( $n = 24$ ) were late. Bleeding was the most common early complication in six neonates (2.5%), and meatal stenosis was the most common late complication in 10 cases (4.2%). Furthermore, meatal web and the incomplete removal of prepuce were also observed in 11 (4.6%) and nine (3.8%) cases, respectively.

**TABLE 2** The average age of subjects in neonates and children groups

Age	Neonates, day			Children, month		
	Mean, SD	Min	Max	Mean, SD	Min	Max
	19.32 ± 6.5	7	30	46.1 ± 8.8	35	60

**TABLE 3** Overall early and late adverse events rates of circumcisions in all subjects<sup>a</sup>

Early adverse events	N (%)	Late adverse events	N (%)
Bleeding	9 (1.9)	Meatal stenosis	14 (2.9)
Urinary retention	6 (1.3)	Fistula	1 (0.2)
Infection	4 (0.8)	Chordee	3 (0.6)
Necrosis	0	Inclusion cyst	3 (0.6)
Glans amputation	0	Skin adhesion to glans	9 (1.9)
hematoma	3 (0.6)	Trapped penis	0
Excessive removal of foreskin	4 (0.8)	Penile rotation	5 (1.1)
Overall	26 (5.4)	Overall	35 (7.3)
Incomplete removal of prepuce <sup>b</sup>	12 (2.5)	Web of meatus <sup>b</sup>	15 (3.1)

<sup>a</sup>Bleeding was the most common early complication and meatal stenosis was the most common late complication.

<sup>b</sup>Incomplete removal of prepuce and web of meatus were not complications and were defined as “not very satisfactory” regarding the parent's perception of circumcision appearance.

Among the 240 older boys, complications occurred in 21 cases (8.8%), of which 4.2% ( $n = 10$ ) were early and 4.6% ( $n = 11$ ) were late. Bleeding was the most common early complication in three cases (1.3%), and meatal stenosis was the most common late complication in four cases (1.6%). Furthermore, meatal web and incomplete removal of prepuce were observed in four (1.6%) and three (1.3%) participants, respectively.

Bleeding and meatal stenosis was the most common complication in both groups. Furthermore, the incomplete removal of prepuce and meatal web were the most common adverse events, which were defined as “not very satisfactory” according to the parents' perception of circumcision appearance in both groups. The neonatal circumcisions more significantly had the risk of the incomplete removal of prepuce, meatal web, and meatal stenosis compared to children (RR = 3, 95% CI 5.83–10.81,  $p < 0.04$ ; RR = 2.75, 95% CI 0.9–8.3,  $p < 0.03$ ; RR = 2.5, 95% CI 0.8–7.75,  $p < 0.04$ ; respectively).

## 4 | DISCUSSION

The controversy about the complication rates of circumcision is significant, especially in infancy and early childhood. The main purpose of this study was to determine the relative risk of

complications in infancy and childhood. This study showed that the cumulative rates of circumcision complications were higher in neonates than in children (8.3% vs. 4.4%,  $p < 0.001$ ). Although bleeding and meatal stenosis were the most common complications in both groups, neonatal circumcisions had a significantly higher risk of meatal stenosis compared to children. Furthermore, the incomplete removal of prepuce and meatal web were the most adverse events defined as “not very satisfactory” in both groups; however, the neonatal circumcisions had a significantly higher risk of the incomplete removal of prepuce and meatal web compared to children.

### 4.1 | Comparison of circumcision complications

One study in Iran reported no difference between the complication rates in neonates and children. In general, the obtained rates were as follows: incomplete removal of prepuce (3.6%), excessive removal of foreskin (1.3%), meatal stenosis (0.9%), inclusion cyst (0.7%), rotation of penis (0.5%), and chordee (0.2%).<sup>16</sup> However, in the present study, 16 main adverse side-effects were revealed. The frequencies of the incomplete removal of prepuce and the excessive removal of the foreskin were lower in the present study.

A systematic review determined that the complication rates were 1.5% (0%–16%) in neonates and 6% (2%–14%) in children.<sup>17</sup> In another study, the frequency of complications was 8.5% in children. The inconsistencies in the complication rates were caused by the difference in the circumcisers' training level rather than the participants' age.<sup>18</sup>

A study on 300 children with a mean age of 9 years (3–16 years) reported that the total, early and late complication rates were 4.7%, 1%, and 3.7%, respectively.<sup>14</sup> They studied only a few adverse events (bleeding, pain, retention, and meatal stenosis). However, in the present study, the total rate of complication was 8.8% in children. This difference may be due to this fact that this study comprehensively investigated the minor and major events ( $n = 16$ ).

A study in Pakistan showed that older children had a higher risk of complications than infants. They recommended circumcision to be performed on infants aged below 3 months.<sup>19</sup> In each community, the best timing of this procedure is defined by tradition and faith. Parental decision on neonatal or older boys' circumcision is usually based on the parent's choice and accurate knowledge received from health workers. The providers should be informed of the potential adverse events of circumcision to better counsel the parents for more accurate decisions.<sup>15,20,21</sup> We aimed to provide health workers with deeper knowledge about the adverse events of circumcision to guide their relevant clinical performance and parental counseling.

### 4.2 | Meatal stenosis and meatal web

Meatal stenosis is a potential adverse event of circumcision, and there is a controversy about its rate. Furthermore, there is a

**TABLE 4** The frequency of adverse events in neonates and children circumcision<sup>a</sup>

Complications N (%)	Neonates	Children	RR	CI 95% Lower-Upper	p value
Bleeding	6 (2.5)	3 (1.3)	2	0.51–7.81	0.49
Urinary retention	4 (1.6)	2 (0.8)	2	0.37–10.7	0.68
Infection	2 (0.8)	2 (0.8)	1	0.14–6.98	0.98
Necrosis	0	0	-	-	-
Glans amputation	0	0	-	-	-
hematoma	1 (0.4)	2 (0.8)	- 1.3	0.16–4.61	0.39
Excessive removal of foreskin	3 (1.3)	1 (0.4)	2.5	0.49–12.73	0.44
Meatal stenosis	10 (4.2)	4 (1.6)	2.5	0.8–7.7	0.04
Fistula	1 (0.4)	0	1	0.06–15.8	0.98
Chordee	2 (0.8)	1 (0.4)	1.66	0.4–6.82	0.72
Inclusion cyst	2 (0.8)	1 (0.4)	2.5	0.49–12.63	0.44
Skin adhesion to glans	6 (2.5)	3 (1.3)	2	0.51–7.81	0.49
Trapped penis	0	0	-	-	-
Penile rotation	3 (1.3)	2 (0.8)	1.5	0.25–8.81	0.98
Overall	40 (16.7)	21 (8.8)	2.6	1.46–4.71	0.001
Incomplete removal of prepuce <sup>b</sup>	9 (3.8)	3 (1.3)	3	5.83–10.81	0.04
Meatal web <sup>b</sup>	11 (4.6)	4 (1.6)	2.75	0.9–8.3	0.03

Abbreviations: CI, confidence interval; RR, relative risk.

<sup>a</sup>Overall, the neonates had a higher risk of complications than children (RR = 2.6, 95% CI 1.46–4.71,  $p = 0.001$ ). The neonatal circumcisions more significantly had the risk of the meatal stenosis compared to children (RR = 2.5, 95% CI 0.8–7.75,  $p = 0.04$ ).

<sup>b</sup>Incomplete removal of prepuce and web of meatus define as “not very satisfactory” under parent's perception of circumcision appearance. The neonatal circumcisions more significantly had the risk of the incomplete removal of prepuce and meatal web compared to children (RR = 3, 95% CI 5.83–10.81,  $p = 0.04$ ; RR = 2.75, 95% CI 0.9–8.3,  $p = 0.03$ , respectively).

disagreement on the diagnosis and morphological definition of meatal stenosis. The frequency of this issue is 5%–20%, with RR = 10.3.<sup>22</sup> A study showed that the risk of meatal stenosis was 7.29 in children circumcision.<sup>23</sup> Another study reported a higher frequency of meatal stenosis (40%), especially if the heating cautery device was utilized.<sup>24</sup> In contrast, a systematic review demonstrated that the RR of meatal stenosis was <1.<sup>25</sup> This inconsistency may be caused by misdiagnosis, as in many cases, meatal web is reported as meatal stenosis. A narrow pinpoint meatus with fibrosis is the precise accepted definition of meatal stenosis, and meatal web is defined based on observing the delicate and soft web at the ventral surface of the urethral meatus.<sup>26</sup> In our study, the frequencies of meatal stenosis and meatal web were higher in neonates than in children (4.2% vs. 1.6% and 4.6% vs. 1.6%, respectively). Furthermore, the relative risk of meatal stenosis and meatal web were 2.5 and 2.75 in neonatal circumcision.

Meatal stenosis is usually an unrecognized side-effect of circumcision, and the asymptomatic presentation of meatal stenosis is high. Precise meatal examination is suggested in circumcised neonates and older boys. Furthermore, because of the high incidence of this issue, informed consent should be obtained from the parents.<sup>27</sup>

### 4.3 | Bleeding

Bleeding is a common complication of circumcision. It is mild in most cases and does not require re-control. Underlying diseases such as lichen sclerosis and bleeding disorders can cause severe bleeding and hematoma.<sup>28</sup> In the present study, although the frequency of bleeding was higher in neonates (2.5%) than in children (1.3%) with a relative risk of 2, it was not statistically significant. A comprehensive preoperative evaluation and a history of bleeding disorders should also be considered.

### 4.4 | Cutaneous complications

The most common cutaneous adverse effects of circumcision included the incomplete removal of the prepuce, the excessive removal of the foreskin, chordee, foreskin adhesion to glans, fistula, inclusion cyst, penile rotation, and trapped penis.<sup>29,30</sup> A meta-analysis revealed that new suture devices had fewer cutaneous complications than traditional surgical circumcision.<sup>31</sup> Urethrocutaneous fistula is a rare but serious side-effect of circumcision that concerns the parents and children and

needs reoperation in most situation. Untrained practitioners and unsterility are the most important factors leading to this problem.<sup>32</sup> In our study, the frequency of cutaneous complications was 0.4%–2.5% in neonates and 0.4%–1.3% in children; however, there was no statistically significant difference in skin complications between the two groups. The incomplete removal of the foreskin was observed with a significant relative risk in neonates than children (RR = 3). Proper patient selection, sterility, and correct surgical techniques can decrease the prevalence of circumcision complications.

#### 4.5 | Limitations and recommendations

One of the limitations of this study was that circumcision complications were not studied in children aged below 3 years because of the small number of cases in this age group. This procedure is recommended to be done in medical departments under sterile conditions by well-trained providers. Under these circumstances, the benefits of this surgery outweigh the potentially rare and generally minor adverse effects of circumcision. Furthermore, practitioners should also obtain comprehensive information about the risks and benefits before prohibiting or recommending this procedure in infancy or childhood, and parents should weigh up the risks and benefits and make the best decision based on their personal beliefs and customs to perform circumcision in neonatal or early childhood.

## 5 | CONCLUSION

According to the findings of the present study, although bleeding and meatal stenosis were the most common complication in neonates and older boys, neonatal circumcision had a significantly higher risk of meatal stenosis compared to children. Furthermore, the incomplete removal of prepuce and meatal web were the adverse events defined as “not very satisfactory” in both groups; however, the neonatal circumcision had a significantly higher risk of the incomplete removal of prepuce and meatal web compared to children. This study intended to provide circumcisers with deeper knowledge about the adverse effects of circumcision to guide their relevant clinical performance and parental counseling.

#### AUTHOR CONTRIBUTIONS

**Soheila Siroosbakht:** Conceptualization; data curation; formal analysis; methodology; project administration; resources; software; supervision; validation; visualization; writing – original draft; writing – review & editing. **Bijan Rezakhaniha:** Conceptualization; data curation; investigation; methodology; supervision; validation; writing – original draft; writing – review & editing.

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#### CONFLICT OF INTEREST

Authors have no conflict of interest.

#### DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available from the corresponding author upon reasonable request.

#### TRANSPARENCY STATEMENT

The lead author Soheila Siroosbakht, Bijan Rezakhaniha affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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