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The impact of minor trauma during pregnancy on maternal and neonatal outcomes: A tertiary centre experience

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ABSTRACT

Introduction: The aim of this study was to evaluate the impact of minor trauma during pregnancy on maternal and fetal outcomes in patients managed in a tertiary setting.
Materials and methods: A retrospective single centre case-controlled study was performed between 2005 and 2017 in a university affiliated tertiary obstetric and trauma centre. All pregnant women of 13–36 weeks gestation that presented to the department of emergency medicine with an Injury Severity Score of <9 were identified. Maternal and neonatal outcomes were compared with a control group of non-trauma pregnant women during the study at a ratio of 1:4. Variables found significant on univariate analysis were included in a multivariate regression analysis.
Results: There were 388 patients allocated to the study group and 2528 to the control group. The groups were demographically similar, however trauma was more common amongst first-time mothers and those pregnant with twins. On univariate analysis, minor trauma was associated with lower gestation age at delivery, lower birth weight, more caesarean sections, lower Apgar scores at 1 and 5 min, longer neonatal hospital admissions and an increased incidence of neonatal intensive care admission. On multivariate analysis, minor trauma remained associated with an earlier gestational age at birth (OR 0.863, 95% CI 0.787-0.946, $p = 0.002$).
Conclusion: Pregnant women who sustained minor trauma during pregnancy should be considered at high-risk of early labour.

1. Introduction

Trauma is a leading cause of non-obstetric morbidity and mortality, affecting between 0.13 and 7% of pregnancies [1,2]. Major trauma during pregnancy is associated with spontaneous abortion, placental abruption and uterine rupture [3,4]. Minor trauma during pregnancy is associated with an increased incidence of preterm delivery of up to 15.4% and lower neonatal birth weight [2,5–7]. With regards to fetal demise, the risk is proportional to the severity of the injury sustained as it has been found in up to 61% of pregnant women with major trauma, increasing to 80% if maternal shock is present [8]. Conversely, in minor trauma fetal demise occurs in less than 1% [9].

In order to risk stratify pregnant women suffering from minor trauma, attempts have been made to identify factors that may be associated with these adverse fetal outcomes [9]. However, these efforts have been limited by the variable definitions of minor trauma ranging from trauma that requires hospital admission [8] to that which is classified as non-life threatening [10]. In comparison to these subjective definitions, the Injury Severity Score (ISS) is reproducible, verified and easily implementable with a score of ≤9 being previously described as the cut-off for minor trauma in both pregnant [11] and non-pregnant patients [12]. In the former, higher scores have been found to significantly correlate with both fetal morbidity and mortality [3,13].

The outcomes of pregnant women who sustain minor as defined by

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an ISS score of <9 have been described with 19.5% suffering from preterm labor, abruption in 1.5% and maternal death in 0.1% [14]. However, following minor trauma there seems to be poor correlation between obstetric symptoms and diagnostic tests and the subsequent risk of adverse neonatal outcomes [15]. The inability to identify those who may suffer from adverse fetal outcomes is important as, despite the low absolute risk, up to 60% of fetal deaths occur after minor trauma [16].

Considering the clinical importance of minor trauma in pregnancy, being able to further validate a reproducible score by which minor trauma can be defined is of benefit to clinicians treating these patients as it will permit accurate risk stratification. We hypothesize that pregnant women who sustain trauma with an ISS of <9 during pregnancy with suffer from adverse fetal outcomes. The aim of this study was to explore the impact of minor trauma, as defined by an ISS score of <9, sustained during pregnancy on maternal and neonatal outcomes in patients managed in a tertiary centre setting.

2. Materials and methods

Institutional ethics committee approval was sought and the requirement for informed consent waived in light of the retrospective nature of the study. A retrospective single centre case-controlled study was performed in a university affiliated tertiary centre for obstetric and neonatal care in which almost 14,000 deliveries are performed annually. A regional trauma centre is located on the same campus.

A prospectively maintained electronic trauma database, which records all trauma patients presenting to the Department of Emergency Medicine (ED) via a unique patient identification number, was interrogated. During the study period, between August 2005 and December 2017, all consecutive trauma patients presenting to the ED who were entered into the register with the relevant diagnostic codes for pregnancy were identified. This corresponded to ICD 10 codes O00-O08 – O94-O99 and included codes Z34/35. These patients were allocated to the study group.

The files of each patient were verified according to the following inclusion criteria. Women must have presented to the ED within 6 h of sustaining any form of trauma. This cut off was chosen to maintain the acute nature of the cohort described. Electronic hospital records from both the ED and the trauma register must have been available for review with sufficient data for the ISS to be calculated. This score assigns a numerical value to 6 anatomic regions based on the degree of injury. The highest 3 of these scores are squared and summated giving the ISS [17]. For the purpose of this study, minor trauma was defined as an ISS of <9.

Pregnancy must have been confirmed by a transabdominal or transvaginal ultrasound revealing an intra-uterine pregnancy. The last menstrual period was used to calculate gestational age in combination with fetal measurements from an US performed earlier during pregnancy or the US performed in the ED. Only pregnant women with a gestational age of between 13 and 36 weeks were included in the study. Patients must also have undergone routine evaluation in the ED by the gynaecology/obstetric team at presention. The evaluation consisted of confirmation of the gestational age of the fetus, transabdominal US, fetal monitoring for 1 h and blood tests including full blood count, basic biochemistry, Kleihauer-Betke test and clotting. If any fetal abnormality, or contractions were noted, the period of time of observation with a monitor was extended to 6 h in line with local protocol.

For the patients who met these inclusion criteria, their unique patient identification number was used to subsequently search the hospital's computerized obstetric and neonatal database. This database is maintained in real-time and is continuously updated during labor and delivery. Women were excluded from the study if they gave birth at another hospital, had missing data or were otherwise lost to follow-up. Those with a history of preterm delivery, premature rupture of membranes or low birthweight infants were also excluded from the analysis.

A control group of women without a history of trauma during pregnancy was created using a ratio of 4:1. These women were identified by selecting the two chronological women who gave birth before and after those women identified by the initial search of the trauma database. A similar set of exclusion criteria was applied to the control group as per the trauma group.

In order to achieve the aim of this study, demographic and obstetric data were extracted from patient files. This data included maternal age, parity, birth history, past medical history and the mechanism of injury. This was categorized as stab wound, blunt limb or abdominal trauma, burn, fall from height <2 m and motor vehicle accident. Beyond the mechanism, the type of injury was also noted. The incidence of gestational diabetes and hypertension was also noted. The former was defined as any degree of glucose intolerance recognized during pregnancy whilst the latter was defined as a blood pressure of 140/90 mmHg on at least two occasions during pregnancy. Preterm delivery was recorded and defined as any birth <37 weeks gestation. Gestational age at the time of trauma and delivery, birth weight and birth type were also recorded and defined as either vaginal delivery, with or without induction, or caesarean section. Apgar scores obtained at 1 and 5 min post birth were recorded with a score of <7 being deemed as abnormal. The maternal and neonatal length of hospital stay were calculated and the overall incidence of admission to the neonatal intensive care unit (NICU) was noted.

Statistical analysis was performed using SPSS version 21 (IBM SPSS Statistics for Windows, Version 21.0. Released 2012. Armonk, NY: IBM Corp). Descriptive statistics are displayed as mean or N with standard deviation or percentage in parenthesis unless stated otherwise. Univariate analysis was performed using either Mann Whitney, Chi squared or Fishers exact test as appropriate in a two-tailed manner. A p value of <0.05 was considered significant. Variables found to be significant on univariate analysis were included into a binomial multivariate regression analysis using an 'enter' technique with trauma as the dependant variable. The results are described as odds ratio (OR) with 95% confidence intervals (CI).

3. Results

During the study period 952 pregnant women suffered minor pregnancy of whom 320 gave birth at another hospital or were lost to follow up. After application of the inclusion criteria, 388 were allocated to the study cohort. Similarly, 174,189 women gave birth at our institution during this time of whom 2528 were allocated to the control group. A flow chart of patient inclusion in the study is shown in Fig. 1. The incidence of minor trauma among the cohort was 0.4%. The data relating to the type and timing of the minor trauma sustained during pregnancy is displayed in Table 1. There were no patients found to have a non-viable pregnancy on the US preformed on presentation to the ED. A majority of women who were included in the study were in the third trimester. The most common type of minor trauma was a fall and the most common injury an abdominal wall contusion.

The background demographic and obstetric data relating to the trauma and non-trauma groups are depicted in Table 2. When comparing these groups, there was no difference in the age of the patients at the time of delivery nor in the incidence of gestational hypertension or diabetes. There were more women in the trauma group who were nulliparous and women who were pregnant with twins.

The univariate analysis comparing the obstetric and neonatal outcomes between the trauma and control groups is displayed in Table 3. Patients allocated to the trauma group were more likely to have a preterm delivery and the mean gestational age at delivery was also lower. Furthermore, the birthweight of these infants was lower and they were more likely to be born via caesarean section. The incidence of Apgar scores <7 was higher at both 1 and 5 min in the trauma group as was the rate of NICU admission. The infants, but not mothers, in the trauma group also spent longer in hospital. The variables found to be significant on univariate analysis were included in a multivariate regression

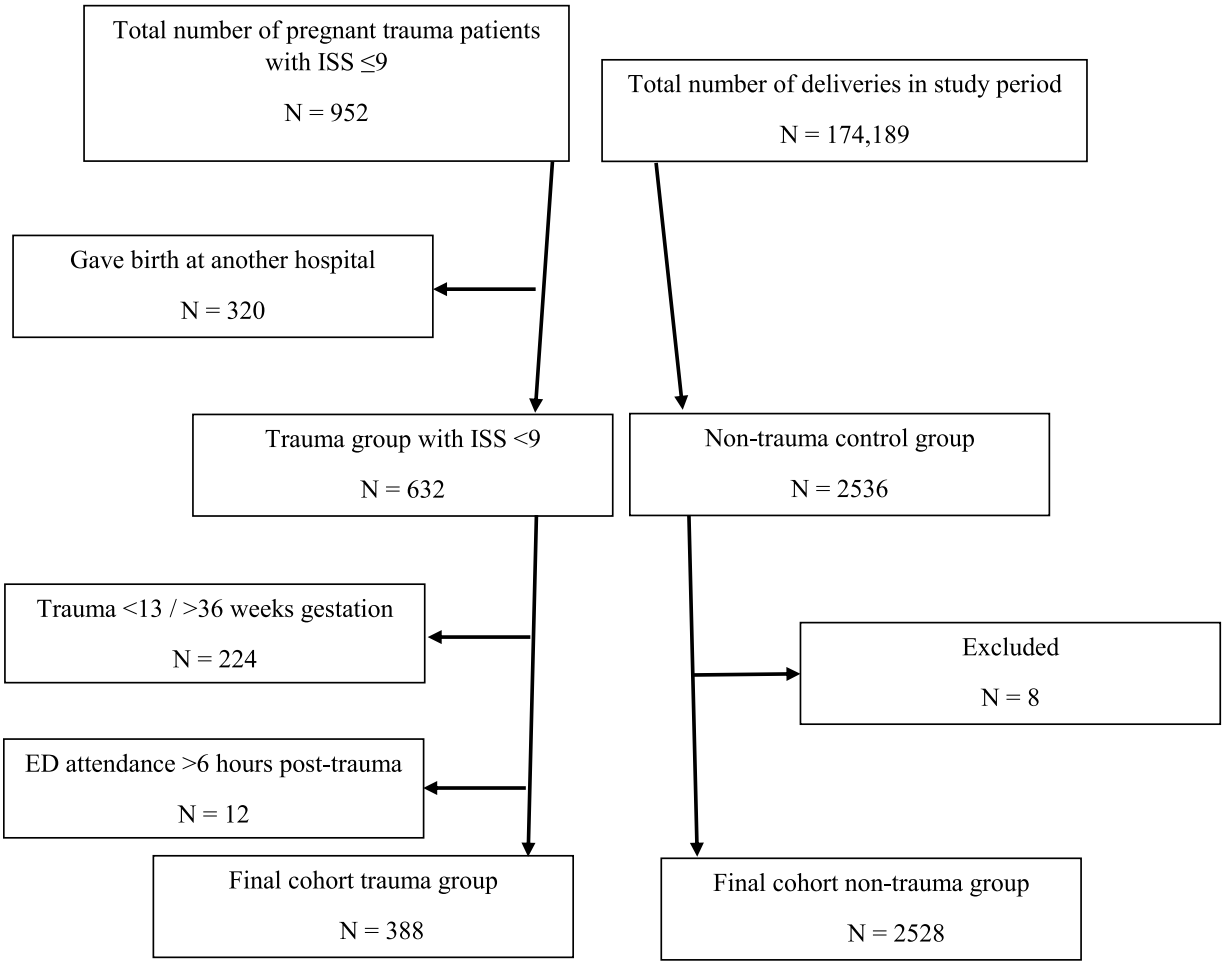

Fig. 1. A flow chart describing patient inclusion in the study
This figure shows that of the 952 pregnant women who presented to our ED after suffering minor trauma, 632 subsequently gave birth at the same center. After application of the inclusion criteria (presentation to the ED within 6 h of sustaining trauma, as ISS score of <9, pregnancy confirmed by a transabdominal or transvaginal ultrasound, evaluation by the gynaecology/obstetric team, be of 13 to 36 weeks gestation) 388 were included in the final cohort. Similarly, of the 174,189 pregnant women who did not suffer from trauma during their pregnancy, 2528 were allocated to the non-trauma control group.

analysis, the results of which are described in Table 4. Minor trauma during pregnancy was found to be independently associated with a younger gestational age at delivery (OR 0.863, 95% CI 0.787-0.946, p = 0.002).

4. Discussion

In the present study we aimed to describe the maternal and fetal outcomes of pregnancy patients who suffered from minor trauma, as defined by an ISS score of <9. We have shown that minor trauma in pregnant patients was independently associated with birth at an earlier gestation.

The incidence of minor trauma described in this study was similar to the reported incidence in previous large-scale studies [1]. In studies from the United States, Europe and the Far East motor vehicle accidents were reported as the main cause of trauma in this specific group of patients [18,19]. However, in the cohort presented here the main cause of trauma was a fall. In keeping with other studies, the incidence of penetrating trauma was low [20]. This may reflect the urban setting of this study or the reliance on public transport considering the local cost of owning and maintaining a car.

Previous studies have found that the severity of the injury correlates strongly with adverse maternal outcomes and poor neonatal prognosis [19,21]. More specifically, clinical variables suggestive of major trauma such as maternal hypoxia [22], shock [23] and disseminated intravascular coagulation [24] are associated with fetal death. Therefore, guidelines suggest that the mainstay of treating pregnant patients who suffer from major trauma is to ensure prompt resuscitation in accordance with Advanced Trauma Life Support principles to prevent hypotension and hypoxia as a means to minimize maternal and fetal morbidity and mortality [25,26].

However, identifying and treating pregnant patients who suffer from minor trauma and are at risk of adverse neonatal outcomes is challenging [27]. This is because cardiotocography, routine blood tests and bedside ultrasound have all failed to predict negative fetal outcomes specifically following minor trauma during pregnancy [10,28].

Adding to this difficulty is a lack of a formal definition of minor trauma which varies from minor falls, low speed motor vehicle accidents and low impact abdominal trauma to injuries that did not require admission to hospital. The effect of these varying definitions is that whilst some studies found minor trauma during pregnancy to be associated with negative fetal outcomes, others found this not to be the case [10,19,29,30].

Exploring the impact of minor trauma within the setting of a reproducible and implementable scoring system is of significant practical importance. This is because using clinical parameters alone can lead to under triage when assessing pregnant trauma patients [31]. In addition, other trauma scores such as the Glasgow Coma Scale, the Abdominal Abbreviated Injury Score, the Revised Trauma Score and the Trauma Injury Severity Score fail to accurately predict fetal outcomes

Table 1
Trauma and trimester characteristics for the minor trauma group of women.

Variable	N = 388 N (%)
Trimester at time of trauma	
2nd	78 (20.1 %)
3rd	310 (79.9%)
Non-viable fetus on ultrasound	0 (0.0%)
Mechanism of injury	
Stab wound	1 (0.3%)
Blunt limb trauma	77 (19.8%)
Blunt abdominal trauma	5 (1.3%)
Burn	2 (0.6%)
Fall from height <2m	189 (48.7%)
Motor vehicle accident	114 (29.4%)
Type of injury sustained	
Head injury	22 (6.5%)
Scalp laceration / facial abrasion	25 (7.4%)
Burn	15 (4.4%)
Sprain / fracture / dislocation:	
Hand	2 (0.6%)
Upper limb	10 (2.9%)
Foot	17 (5.0%)
Lower limb	19 (5.6%)
Chest wall contusion	8 (2.4%)
Abdominal wall contusion	225 (66.6%)
Upper limb abrasion	27 (8.0%)
Lower limb abrasion	35 (10.4%)
Pelvic fracture	1 (0.3%)
Splenic contusion	1 (0.3%)

Table 2
Demographic and pregnancy related characteristics of the study groups.

Variable	Total N = 2916 N/mean (%/±SD)	Non-trauma group N = 2528 N/mean (%/±SD)	Trauma group N = 388 N/mean (%/±SD)	P value
Maternal age (years)	29.1 (±5.7)	28.8 (±5.8)	29.4 (±5.8)	0.484
Gestational diabetes mellitus	96 (3.3%)	86 (3.4%)	10 (2.6%)	0.397
Gestational hypertension	76 (2.6%)	61 (2.4%)	15 (3.9%)	0.094
Parity:				
1	727 (24.9%)	608 (24.1%)	119 (30.7%)	0.005
≥2	2189 (75.1%)	1920 (75.9%)	269 (69.3%)	
Twin pregnancy	65 (2.2%)	50 (2.0)	15 (3.9%)	0.019

Table 3
Maternal and neonatal outcomes: univariate comparison of the study groups.

Variable	Non-trauma group N = 2528 N/mean (%/±SD)	Trauma group N = 388 N/mean (%/±SD)	P value
Preterm delivery	144 (5.7%)	67 (17.3%)	<0.001
Gestational age at birth (weeks)	39.7 (±1.2)	38.1 (±2.8)	<0.000
Birth weight (g)	3572.3 (±313.7)	3075.3 (±617.8)	<0.001
Caesarean section	321 (12.7%)	71 (18.3%)	<0.003
Apgar 1 <7	48 (1.9%)	14 (3.6%)	<0.026
Apgar 5 <7	10 (0.4%)	6 (1.5%)	<0.004
Post-delivery maternal length of stay (days)	2.6 (±0.9)	3.0 (±1.6)	0.186
Post-delivery neonatal length of stay (days)	3.9 (±6.7)	5.6 (±9.9)	<0.001
NICU admission	95 (3.8%)	42 (10.8%)	<0.001

Table 4
Maternal and neonatal outcomes among the study groups: a multivariate analysis.

Variable	OR	95% CI	P value
Preterm delivery	0.744	0.427-1.299	0.299
Gestational age at birth (weeks)	0.863	0.787-0.946	0.002
Birth weight (g)	>0.999	1.00-1.00	0.459
Caesarean section	0.942	0.683-1.299	0.717
Post-delivery neonatal length of stay (days)	0.991	0.976-1.001	0.246
NICU admission	0.836	0.458-1.524	0.836
Apgar 1 <7	1.377	0.599-3.165	0.452
Apgar 5 <7	1.090	0.253-4.696	0.908

[32–34]. In comparison, whilst various ISS scores have been used to delineate between minor and major trauma, a score of >9 has an 85.7% sensitivity and 70.9% specificity for predicting fetal demise [3]. Therefore, considering the lack of other clinical and biochemical markers that accurately predict fetal outcomes following minor trauma, we suggest using an ISS of <9 to identify pregnant patients at risk of these adverse outcomes. Further research is needed to appreciate what can be done to mitigate fetal risk for these patients. This is particularly pertinent as proposed treatment algorithms for the pregnant trauma patient, have yet to be associated with an improvement in fetal outcomes [25].

The causative factors explaining the relationship between minor trauma and adverse neonatal and maternal outcomes are poorly understood. As the shearing forces of major trauma have been associated with an increased risk of placental abruption, it may be that minor trauma causes subclinical placental abruption which in turn result in the negative neonatal outcomes described above [20,35].

The evidence exploring the incidence of trauma amongst nulliparous mothers, as observed in our study, is limited to case reports or individuals as part of larger cohort [30,36]. It is possible that 'inexperienced' nulliparous patients are more prone to accidents, especially falls, in comparison to multiparous patients [37]. It is also possible that multiparous, more experienced, patients are also less likely to present to hospital following minor trauma. This may explain the relatively large number of trauma patients who were pregnant with their first child in the cohort presented here.

The strengths of this study are that the inclusion criteria are based on a reproducible and validated scoring system. Furthermore, it is based on a large cohort size, larger than any other single centre published to date covering a timespan of almost a decade. This may, in part, compensate for changes in population characteristics and treatment protocols.

There are several limitations to this study. It is retrospective in nature affecting the quality of data collection. Selection bias was introduced as it was not possible to include those who were lost to follow up or who gave birth in a different healthcare system. This may underestimate the true incidence of fetal loss, which we were unable to report. Therefore, despite the outcomes demonstrated above, we were unable to compare and contrast these results with a non-tertiary centre. In addition, patients in the first trimester were not included in the study limiting the ability to generalize the outcomes of minor trauma on neonatal and maternal outcomes in the specific subset of patients. Finally, there may have been factors associated with both early labour and trauma not included in the present analysis.

5. Conclusion

In conclusion, we have shown that minor trauma sustained during pregnancy who were managed in a combined tertiary obstetric and trauma centre was associated with delivery at an earlier gestational age. We suggest that this group of patients be considered as high risk for early labour. Further research is required to understand the underlying cause of this relationship.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.sipas.2023.100160.

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