Are Existing Classification Systems Adequate for Open Pelvic Injuries?

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Section 1: Background

Open pelvic fractures are high-energy injuries in which the bony pelvis communicates directly with the overlying skin, rectum, vagina, or genitourinary system. They are uncommon, representing only 2–4% of all pelvic fractures,[3,11] but carry a disproportionate mortality burden, historically 30–50%,[2,8] and still 15–45% in contemporary series making them among the most lethal injuries encountered in trauma surgery.[5,9,10]

Conventional pelvic fracture classification systems, principally the Tile/AO-OTA and Young-Burgess systems stratify injuries by mechanical pattern and bony stability.[3] These remain the foundation of orthopaedic decision-making for pelvic ring injuries. However, both systems were derived from, and validated in, predominantly closed pelvic fractures, and neither was designed to account for the critical features that make open pelvic injuries uniquely lethal, the loss of retroperitoneal tamponade, exposure to external and enteric contamination and direct visceral communication resulting in pelvic sepsis.

Several classification systems have been proposed specifically for open pelvic fractures. The Faringer zone classification (1994) stratifies injuries by anatomical wound location (Zone I: perineum/pubis/sacrum; Zone II: medial thigh/groin; Zone III: posterolateral buttock/iliac crest), primarily to guide fecal diversion decisions.[2,5,9] The Jones-Powell system (1997) incorporates pelvic ring stability and rectal/perineal wound presence, producing three classes with escalating mortality.[1] The Bircher classification (2004) further subdivides open fractures into outside-in, inside-out, and severe contamination subtypes.[3] Wang and Li (2019) proposed a regional injury classification specifically to correlate anatomical injury distribution with mortality and combined injury patterns.[4]

Despite these efforts, no single classification system captures all parameters relevant to the management and prognosis of open pelvic injuries. None of the classification integrates bony stability, hemodynamic status, wound contamination, visceral injury, and sepsis risk into a unified framework. Furthermore, existing systems have been validated in small, predominantly retrospective single-centre studies, limiting their generalisability and reliability. The literature consistently demonstrates that physiologic scores such as Revised Trauma Score (RTS), Injury Severity Score (ISS), and admission lactate outperform anatomical classifications as independent predictors of mortality.[5,9,10] This raises the fundamental question of whether current classification systems are fit for guiding the management of open pelvic injuries.

Section 2: Data Extraction Table

S.No	Author, Year, Country	Study Design	Sample Size	Study Population	Classification Systems Used	Key Findings	Limitations
1	Jones et al., 1997, USA/Canada (Multicenter)	Retrospective multicenter chart review	39 patients	Open pelvic fractures at 3 trauma centres, 1979-1989. MVA predominant mechanism.	Tile classification (bony); Gustilo-Anderson (soft tissue severity); Proposed Jones-Powell Classification (open pelvic-specific)	Proposed Jones-Powell 3-class system based on pelvic stability and rectal/perineal wound presence. Class 1 (stable, no rectal injury): 0% mortality; Class 2 (unstable, no rectal injury): 33%; Class 3 (unstable + rectal injury): 44%. Classification predicted both mortality and sepsis risk. Tile and Gustilo-Anderson alone were insufficient for open pelvic injuries.	Small sample (n=39). Retrospective. Old study (1979-1989). Limited follow-up
2	Dente et al., 2005, USA (Level I)	Retrospective cohort	44 patients	Open pelvic fractures at Grady Memorial Hospital, 1995-2004. Urban level I trauma centre.	Young-Burgess (bony); Gustilo-Anderson (soft tissue); Faringer (wound zone)	Overall mortality 45%. **Faringer zone I/II injury predicted mortality** (zone I: 58%; zone III: 8%; zone II: 67%). Gustilo III predicted mortality. Concomitant intra-abdominal injury: 89% mortality. **No existing classification captured severity of combined injury adequately.**	Retrospective, single centre, small sample. No independent risk factors identified on multivariate analysis.
3	Petrisor & Bhandari, 2005, Canada (Review)	Narrative review / epidemiological review	Review article (no original cohort)	Review of existing literature on pelvic ring injuries including open fractures. Canadian	Tile/OTA (stability); Young-Burgess (mechanism); Jones-Powell; Bircher-Hargrove,Gustilo-Anderson	Existing classifications (Tile, Young-Burgess) do not specifically address open pelvic injuries. Jones-Powell captures rectal contamination risk but needs further validation. Bircher classification	Review article - no primary data. Heterogeneous literature review. Limited prospective data available.

				registry data referenced.		addresses open fractures specifically but is complex and unstudied. Open pelvic fractures with rectal injuries have up to 77% sepsis rate. Gustilo classification difficult to apply strictly to pelvis	
4	Wang & Li, 2019, China	Retrospective cohort	67 patients	Open pelvic fractures, Jan 2001-Dec 2017. Affiliated Hospital of Chengdu University. Excluded penetrating injuries and incomplete data.	Tile (bony); Gustilo-Anderson (soft tissue); Faringer (wound zone); Proposed Regional Injury Classification (new, 4-type: perineal/ilioinguinal/sacroiliac/composite)	Overall mortality 41.8%. Proposed new regional injury classification correlates with mortality (Type I: 20.7%, Type II: 45%, Type III: 71.4%, Type IV: 72.7%,(p=0.001). Each region has distinct associated injury patterns and treatment implications. **Existing systems (Hanson, Jones-Powell, Bircher, Faringer) fail to identify key causes of death and guide emergency treatment**.	Single centre. Retrospective. Does not include degree of soft tissue injury or fracture stability. No external validation..
5	Tseng et al., 2020, Taiwan (Level I)	Retrospective cohort	37 patients	Open pelvic fractures, Jan 2014-Jun 2018, Level I trauma centre, Chang Gung Memorial Hospital.	AO/OTA (bony stability); Gustilo-Anderson (soft tissue); Faringer (wound zone); Jones-Powell	Mortality 21.6%. On multivariate logistic regression, RTS was the only independent predictor of acute mortality. Wound location (Faringer zone) and fracture classification (AO/OTA) were not independent predictors of mortality. This suggests **existing open pelvic-specific classifications (Faringer, Jones-Powell) have limited standalone predictive**	Small sample (n=37). Single centre. Retrospective. Small sample size, Referral centre bias.

						value for early mortality.	
6	Li et al., 2022, Taiwan/USA (NTDB)	Retrospective database study - National trauma data bank (NTDB) 2015	830 patients	Open pelvic fractures in NTDB 2015. Blunt trauma only. Excluded penetrating, burns, severe head injury (AIS head ≥3).	WSES classification (hemodynamic + mechanical stability); Sepsis as supplementary variable	WSES minor/moderate/severe correlated with mortality (3.5%/11.2%/23.8%, p<0.001). WSES AUC=0.717 alone. Sepsis was independent predictor of mortality (OR 9.74, p<0.001). WSES + sepsis: AUC=0.767. **Existing WSES system - designed for closed fractures - is applicable to open fractures but requires supplementation with sepsis evaluation** to be adequate.	Retrospective. Hemodynamic instability defined at admission only (no resuscitation response).
7	Yu et al., 2023, Taiwan (Level I)	Retrospective case series	19 patients	open pelvic fractures who underwent osteosynthesis, 2014-2018. Excluded non-operative and lost to follow-up.	AO/OTA (bony); Faringer (wound zone); Jones-Powell; Matta/Tornetta and Lefaivre criteria (reduction quality)	Functional outcomes assessed by Merle d'Aubigne and Majeed scores over 36 months. Outcomes improved initially then plateaued at 24 months. **Excellent pelvic ring reduction correlated with best functional outcomes**. Classification systems used were adequate for guiding fixation but lacked functional outcome prediction.	Small sample (n=19). Single centre. Short follow-up (mean 39 months). High attrition from primary cohort of 37. Only functional outcome studies. No data on mortality with respect to classification of injury.
8	Cannada et al., 2013, USA (Multicenter)	Retrospective multicenter study	64 patients	Open pelvic fractures, 2000-2006, 6 Level I trauma centres Ages 16-65.	Young-Burgess (bony); Jones-Powell Classification	Overall mortality 23%. Jones-Powell Class 1: 0%, Class 2: 24%, Class 3: 38%. Unstable pelvic ring +/- rectal injury independently predicted	Retrospective. No standardised protocol (6 centres). Coding errors found (few open-book

						mortality ($p<0.05$). However, rectal laceration was not independently associated with late sepsis when diverting colostomy performed within 48h. ISS played greater role in mortality than classification alone. **Rectal laceration as a marker of injury severity rather than a direct independent predictor**.	fractures coded as open pelvic fractures). Variable use of interventions.
9	Guo et al., 2020, China (Level I)	Retrospective cohort with literature review	46 patients	Open pelvic fractures, Jan 2013-Dec 2017, Daping Hospital. Excluded age <18 and prehospital deaths.	Tile (bony); Gustilo-Anderson (soft tissue); Faringer (wound zone); Jones-Powell	Mortality 17.4%. ISS and lactate on admission were independent risk factors for mortality on multivariate analysis. No classification system parameter (Tile, Faringer zone, Jones-Powell class, Gustilo grade) was independently associated with mortality on multivariate analysis.	Single centre retrospective. Small n=46. Broad literature review includes heterogeneous populations. Classification of open fractures itself (Gustilo) may not apply well to pelvis.
10	Dong & Zhou, 2011, China	Retrospective cohort	41 patients	Open pelvic fractures, Jan 2001-Apr 2010, Provincial Hospital affiliated to Shandong University.	Young-Burgess (bony); Gustilo-Anderson (soft tissue); Faringer (wound zone)	Mortality 24%. On univariate analysis: ISS, RTS, GCS, age, pelvic sepsis, Gustilo classification, Young classification all significant. On **multivariate analysis: only RTS ≤8 independently predicted both overall and late mortality.** Faringer zone, urogenital injury, intra-abdominal injury did NOT independently predict	Small sample (n=41). Single centre. Retrospective. No angiography routinely available. Variable fixation strategies.

						mortality. Again **demonstrates limitations of anatomical classification systems in predicting outcome.**	
11	Black et al., 2011, USA	Retrospective cohort (10-year series)	52 patients	Open pelvic fractures 1999-2009	Young-burgess classification	Mortality 19%. Blunt trauma predominant. Open pelvic fractures have higher mortality than closed pelvic fractures. Mortality increased with transfusion requirement	Retrospective. Single centre. Limited classification details
12	Maina & Wanjara, 2023, Kenya	Retrospective case series	8 patients	Open pelvic fractures, Jan 2012-Dec 2022, two Kenyan teaching hospitals. All referrals. Minimum 6 months follow-up.	Young-Burgess (bony); Faringer (wound zone); Bircher definition of open pelvic fracture adopted (includes internal open injuries)	No mortality. All achieved independent ambulation. Faringer zone classification guided fecal diversion decisions (Zone I patients received colostomy). Early sepsis control, fracture fixation, and multidisciplinary approach produced satisfactory outcomes (mean Postel score 17).	Very small sample (n=8). All patients GCS 15 on admission - selection bias (Milder injury burden). Referral only population. Resource-limited context limits generalisability.

Section 3: Results Summary

Twelve studies published between 1997 and 2023 were included, collectively reporting on 1,252 patients with open pelvic fractures across trauma centres in the USA, China, Taiwan, Canada, Kenya, and European registry data. Studies ranged from small case series (n=8) to large registry analyses (n=830). Overall mortality across studies ranged from 0% (Maina 2023, small selected series) to 45% (Dente 2005), with most contemporary series reporting 17–24%.

Multiple classification systems were applied across included studies: Tile/AO-OTA and Young-Burgess (bony stability, all studies), Gustilo-Anderson (soft tissue severity, most studies), Faringer zone (wound location, 8/12 studies), Jones-Powell (open pelvic-specific, 6/12 studies), WSES (hemodynamic + mechanical, 1 study), and newly proposed systems including Wang's regional injury classification and Bircher's subtype scheme.

Across studies, the following patterns consistently emerged. First**, no anatomical classification system was independently predictive of mortality on multivariate analysis**. In two separate multivariate analyses (Tseng 2020, Dong 201), Revised Trauma Score (RTS) was a sole independent predictor of acute and overall mortality. ISS and admission lactate were independently predictive in one further study (Guo 2020). **Faringer zone, Jones-Powell class, Tile type, and Gustilo grade did not independently predict mortality**

Second, the Jones-Powell classification correlated with escalating mortality rates (Class 1: 0%, Class 2: 24–33%, Class 3: 38–44%) across multiple studies (Jones 1997, Cannada 2013), and unstable pelvic ring with or without rectal injury was an independent predictor of mortality in the Canada 2013 multicenter study. However, Tseng (2020) found Jones-Powell class was not a significant predictor, and Guo (2020) found no significant difference between classes on multivariate analysis.

Third, the WSES classification system (Li 2022) demonstrated acceptable discrimination for open pelvic fractures (AUC 0.717) , but required sepsis as a supplementary variable to improve discriminatory performance to AUC 0.767. This reflects the unique biology of open pelvic injuries: **pelvic sepsis, not captured in standard bony or hemodynamic classifications is an independent predictor of mortality with an odds ratio of 9.74**.

Fourth, Wang and Li (2019) proposed a regional injury classification that correlated with mortality (gamma coefficient 0.620, $p<0.001$) and was associated with distinct combined injury patterns for each subtype. This represented the most targeted classification attempt, but relies on injury topography alone and has not been externally validated.

For functional outcomes in open pelvic fractures, Yu (2023) demonstrated that quality of pelvic ring reduction was the dominant determinant of 3-year functional scores — a relationship captured by the AO/OTA fracture classification ,Matta criteria, and Lefaivre criteria framework, though not by any open pelvic-specific system.

Section 4: Discussion

4.1 Why Existing Classifications Fall Short

The fundamental inadequacy of existing classification systems for open pelvic injuries stems from the fact that most systems were designed for a fundamentally different injury. The Tile/AO-OTA and Young-Burgess systems codify bony anatomy and mechanical instability , critical parameters for internal fixation planning and hemodynamic risk stratification in closed fractures , but they are systematically blind to the features that drive morbidity and mortality in open fractures viz. wound contamination, visceral communication, faecal contamination risk, soft tissue viability, and the subsequent trajectory toward either early hemorrhagic death or delayed sepsis-driven death.

When applied to open pelvic fractures, both systems show heterogeneous distributions without clear mortality stratification. As it can be inferred from Wang et al(2019) study, open pelvic fractures which are stable still may carry a substantial mortality burden when they occur in the perineal or sacroiliac region.

The **Gustilo-Anderson system widely used as a soft tissue classification for long bone open fractures cannot be directly applied to the pelvis**. Petrisor and Bhandari (2005) in their review highlighted that strict categorical classification is difficult given the complex anatomical relationship of soft tissues and the peculiar entity of enteric contamination in open pelvic fractures, which automatically categorises most open pelvic fractures as Type III regardless of wound size.

No existing classification system for open pelvic fracture incorporates physiologic scoring (eg. revised trauma score) or parameters (lactate, base excess, PRBC transfusion requirement) that has been shown to directly influence mortality in open pelvic fractures.

4.2 Performance of Open Pelvic-Specific Systems

The Jones-Powell classification represents the most clinically adopted open pelvic-specific system. It is intuitive, a stable pelvis without rectal contamination (Class 1) carries low risk; an unstable pelvis with rectal injury (Class 3) is high risk .This has been partially validated across multicenter data. However, its limitations are substantial. It was originally derived from only 39 patients. Validation studies (Cannada 2013, Tseng 2020, Guo 2020) have shown inconsistent performance as an independent mortality predictor once overall injury severity is accounted for. The system does not capture vascular injury, degree of soft tissue destruction, hemodynamic status, or contamination extent. Tseng (2020) specifically noted that wound location per Jones-Powell class was not a causative etiology of early mortality.

The Faringer classification, while clinically practical for deciding fecal diversion, was never designed as a prognostic tool and has shown limited independent predictive value across studies. Giordano (2016, cited in Tseng 2020) noted that Faringer's system was not suitable for acute management of bony components. Li (2022) showed that although Faringer zone I injuries carry high contamination risk, the independent mortality driver remained hemodynamic status and sepsis rather than wound zone per se.

Wang's regional injury classification (2019) is the most comprehensive attempt to integrate anatomical injury patterns with mortality and combined injury profiles. Its correlation with mortality is statistically significant and clinically meaningful, and it provides a useful therapeutic flowchart. However, it still omits physiologic status, does not address soft tissue degree of injury, and awaits external validation in other populations.

The WSES classification is the only system that integrates both mechanical and hemodynamic parameters, representing a more holistic view of pelvic injury severity. Li (2022) demonstrated acceptable discrimination for open fractures (AUC 0.717). The requirement to supplement it with sepsis data (AUC 0.767) further supports the unique pathophysiology of open injuries that no purely mechanical (stability) classification system can adequately capture.

4.3 What an Adequate Classification System for Open Pelvic Injuries Should Include

The literature suggests that an ideal classification system for open pelvic injuries should integrate: (1) bony stability (Tile/AO-OTA type); (2) hemodynamic status at presentation; (3) wound location and contamination zone (modified Faringer); (4) rectal/visceral communication; (5) associated vascular/other system injury; and (6) physiologic reserve (RTS or lactate). No currently validated system incorporates all six domains. This represents the key gap in the existing literature.

4.4 Clinical Implications

For the practising trauma surgeon, the current evidence suggests the following: **existing classifications should be used in combination rather relying on any one particular system**. The Jones-Powell classification remains useful as a rapid communication system, Faringer anatomical zone classification helps in assessing need for fecal diversion. but not be the sole determinant of management. The WSES classification, supplemented by sepsis status, offers the best validated prognostic discrimination currently available. Physiologic scores (RTS, ISS, lactate) are the strongest mortality predictors and should drive resuscitation. A new consensus classification that integrates these domains is warranted and should be a research priority.

Section 5: Risk of Bias of Included Studies

Overall Risk of Bias: MODERATE TO HIGH

The body of literature on open pelvic fracture classification is characterised by the following methodological limitations:

- All included studies are retrospective in design — no prospective studies or RCTs exist on this topic, largely due to the rarity and acuity of the injury.
- Sample sizes are uniformly small (range n=8 to n=64 for single-centre studies; n=830 for the large NTDB registry study), limiting statistical power and generalisability.
- Heterogeneous definitions of open pelvic fracture exist across studies, with some including internal open injuries (vaginal, rectal communication without skin breach) and others requiring external skin communication.
- Management protocols varied significantly across institutions and time periods, introducing confounding in comparative analyses.
- Most studies are single-centre with significant selection bias (referral centres, survivor bias post-prehospital death).
- The NTDB-based study (Li 2022) benefits from large numbers but is limited by retrospective nature, absence of management detail, and use of a single-year dataset.
- The Maina et al. (2023) case series from Kenya, while methodologically sound for its context, has very small sample (n=8) with likely significant selection bias toward milder injuries (all GCS 15 on admission).

Section 5: Response / Consensus Recommendation

Existing classification systems — including Tile/AO-OTA, Young-Burgess, Gustilo-Anderson, Faringer zone, and Jones-Powell — are individually inadequate for open pelvic injuries as they were designed primarily for closed fractures, do not integrate hemodynamic status, sepsis risk, or visceral contamination, and fail to independently predict mortality on multivariate analysis; **a new consensus classification that incorporates bony stability, hemodynamic status, wound contamination zone, visceral communication, and physiologic reserve is required and should be a priority** for future prospective multicentre research.

Section 6: Level / Strength of Evidence

Level of Evidence: LOW

Justification: The entire body of evidence on this topic consists of Level III and IV studies — retrospective case series and cohort studies, one large retrospective database analysis, and narrative reviews. No prospective studies, RCTs, or meta-analyses specifically addressing classification system adequacy for open pelvic fractures exist. Sample sizes are small, heterogeneity in patient populations and management protocols is high, and most classification-specific findings are derived from underpowered univariate analyses. The rarity of the injury makes higher-level evidence generation inherently challenging. The evidence base, while consistent in identifying the limitations of existing systems, cannot provide strong endorsement for any single replacement classification.

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