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Comparative Study - Retrospective Cohort

Charlson comorbidity index predicts postoperative complications in surgically treated hip fracture patients in a tertiary care hospital: Retrospective cohort of 1045 patients

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ABSTRACT

Introduction: Hip fractures are of major concern due to the aging population worldwide. Surgery on this vulnerable population carries high risk. Charlson comorbidity index (CCI), has been reported to predict the mortality in these patients. Investigators in this study aimed at studying the prediction effect of CCI on hip fracture surgery complications after controlling other patents' and procedures' related factors.
Methodology: We conducted a retrospective cohort of 1045 patients with hip fractures who were treated surgically at our tertiary care and level 1 trauma Center between 2010 and 2018. Primary exposure was CCI and primary outcome was in-hospital and 30 days postoperative complications (major and minor). Cox proportional algorithm analysis was done at univariate and multivariable levels to report Crude Relative Risk (RR) and Adjusted Relative Risk (aRR), respectively. Results were reported in line with STROBE criteria.
Results: Exposed group included 867 (83%) of patients with 340 (39%) males. Postoperative complications occurred in 449 (43%) of the patients in exposed group with (62) 6% patients admitted in ICU postoperatively. At multivariable model, CCI was significantly associated with postoperative complications; patients with moderate-severe systemic diseases were 1.45 times (95% CI: 1.05–1.99) at risk of developing postoperative complications as compared to patients with low CCI scores after controlling for other variables in the model. Other significant factors included ASA status and postoperative ICU admission.
Conclusion: CCI can be a good predictor independent variable of postoperative complications after hip fracture surgery. These patients need extra care and counseling to reach an informed decision keeping in mind the benefits versus risks of surgery. We recommend multi-center studies for corroboration.

1. Introduction

The number of hip fractures increases exponentially with age and is more common in elderly females [1,2]. A decline in cognitive and physical function predisposes elderly patients to falls and combined with osteoporosis, places this population at a higher risk of fractures.

Hip fractures are associated with significant mortality particularly in patients with pre-existing comorbids [3]. The risk of mortality is highest in the first 4 weeks after fracture [3,4] with one-third of patients dying within one year [5,6]. The majority of deaths post-hip fracture are because of cardiovascular events and pneumonia with post-operative complications including delirium, pneumonia, acute cardiovascular events and pulmonary embolism also as contributing factors [4,6].

Numerous studies have shown the effect of pre-fracture comorbidity on post-operative complications and mortality [7–11]. A meta-analysis on pre-operative predictors for mortality identified strong evidence for 12 predictors which included advanced age, male gender, poor pre-operative ambulation status, higher ASA status, dementia, diabetes, cancer, cardiac disease and multiple comorbidities

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amongst others [12]. Although predictors for mortality post hip fracture have been focused on a lot and researched extensively, research regarding use of risk prediction models is relatively limited. These models can help us with risk stratification of individual patients and help understanding the prognosis, ideally at the time of presentation. With pre-surgical assessment of risk factors using these models and the routine application of prophylaxis interventions, the outcomes can be improved. One such tool is the Charlson Comorbidity Index, which is an easy, inexpensive and quick method of assessment. It assigns an integer value from 1 to 6 to a number of conditions, with 6 representing the most severe morbidity.

The CCI has been used previously for prediction of mortality, however very little research is done on prediction of 30-day post-operative morbidity using CCI. We are unaware of any study conducted in tertiary care hospital in South East Asia using CCI to predict morbidity. We chose to study the Charlson Comorbidity Index and its association with 30-day post-operative complications because CCI takes into consideration major medical comorbidities and has demonstrated short-term predictive ability in post-operative complications of hip fracture patients [13]. The purpose of this study is to use CCI to predict the most likely post-operative complications and as a result, help reduce post-hip fracture mortality. We hypothesize that increasing age, male gender and a higher CCI score will be associated with a higher rate of post-operative complications.

2. Material and methods

2.1. Participants and setting

The approval for this study was taken from the University Hospital Ethics Review Committee (ERC). It was a retrospective cohort study that included all patients admitted from January 2010 to December 2018. Our institute is a tertiary care University Hospital and level-1 trauma center. All patients who had hip fracture and underwent surgical procedure for its management were included in this study irrespective of the age and gender. All patients in this study were managed by orthopedic surgeons. All patients underwent preoperative assessment and post-operatively followed standard mobilization protocol with physiotherapy including home physiotherapy after discharge. All patient follow ups were included for 30 days after discharge for this study to monitor any complication that might have developed.

In this study, patients with incomplete or missing information in primary exposure or the outcome were excluded. In addition, patients who underwent revision surgeries, poly trauma, open fractures and pathological fractures were also excluded from the study. Data of 1045 patients were extracted from medical records and analyzed. The study was registered at clinicaltrials.gov and results were reported in accordance with STROCSS criteria [26].

2.2. Variables, primary exposure and outcome

Baseline variables and clinical data of all patients were collected from the medical record database of the institution including age, sex, BMI, walking status prior to surgery and comorbidities, mechanism of injury, American Society of Anesthesiologists grade, length of stay, postoperative intensive care unit stay, duration of surgery, type of procedure and type of surgery. The primary exposure was CCI (Charlson Comorbidity index). It is a validated score used to predict the functional status of patients after 1 year of cardiac surgery and also the 1-year mortality among hospitalized patients based on the severity and presence of illnesses included in this index. Patients were either categorized as low CCI (included none and mild categories) and high CCI (moderate and severe categories).

Outcome of this study was postoperative complications including both medical and surgical complications. In-hospital complications except mortality were included such as retroperitoneal bleed, gastrointestinal bleed, arrhythmia, urinary tract infection, surgical site infection, periprosthetic fracture, pulmonary embolism, deep vein thrombosis, myocardial infarction, new congestive heart failure, pneumonia, hypoxia and renal insufficiency.

2.3. Statistical analysis

Statistical analyses were done by using STATA software version 15.0 for Windows. The study assessed the effect of CCI on postoperative complications in 1045 patients. Descriptive characteristics of patients were characterized into two groups that included patients with high CCI and patients with low CCI. For categorical variables, two groups were compared by using Chi Square and for continuous variables independent T test was used to compare the means of two groups. To determine the relationship between CCI and postoperative complications, Cox proportional algorithm was used. For univariate analysis, the cutoff was set to be p-value$<$0.25. The univariate analysis was followed by multi variable analysis to adjust for other independent factors including confounders. Risk ratio along with 95% CI was reported for each variable that was significant in multivariable analysis.

3. Results

3.1. Demographics and background characteristics of the study participants

After screening, 1045 patients who underwent orthopedic surgeries were included into the final analysis (Fig. 1). About 83% of patients were high CCI score while 17% were having low CCI score. In the unexposed group, 1/4th of patients (28%) had post-operative complications. On the other hand, in the exposed group, 42.62% of patients had post-operative complications.

Table 1 shows the demographic characteristics of patients in exposed group and in unexposed group. The mean age of patients who had low CCI score was 42 years whereas mean age of patients with high cci was 73 years. In exposed group, number of females (60%) is higher than males (40%). Similarly, in unexposed nearly 2/3rd are males (65%). Among patients with low CCI score, only 1% were admitted in ICU after surgery, while in patients with high CCI, nearly 6% were admitted in ICU after surgery. More than half of patients (53%) in exposed group had undergone Dynamic hip screw (DHS) procedure and in unexposed group, 36% of patients underwent Dynamic hip screw (DHS). In exposed and unexposed group, the patients' who underwent emergency surgeries were 44.83% and 51.635% respectively.

Univariate analysis was done to determine the association of independent factors with post-operative complications. For univariate analysis, the cutoff was kept at 0.25. Variables that were significant in univariate analysis include CCI, ASA level, ICU admission, procedure type, age and mechanism of injury. The multivariable model was run for all variables that were significant in the univariate analysis. There was no collinearity between CCI & ASA status, thus both variables were considered in the final modeling.

In multivariable model, CCI was significantly associated with postoperative complications. Patients with high CCI score were 1.45 times (95% CI: 1.05–1.99) at higher risk of developing postoperative complications as compared to patients with low CCI score. ASA level of patients was also significantly associated with the development of postoperative complications. It means patients with ASA level 4 were 1.77 (95% CI: 1.09–2.23) times higher risk developing postoperative complications as compared to ASA level 1. There was also an association between ICU admission and postoperative complications. The patients who were admitted in ICU after surgery had a 1.61 (95%: 1.10–2.37) time higher risk of developing postoperative complications as compared to patients who were not admitted in ICU after the surgery as shown in Table 2.

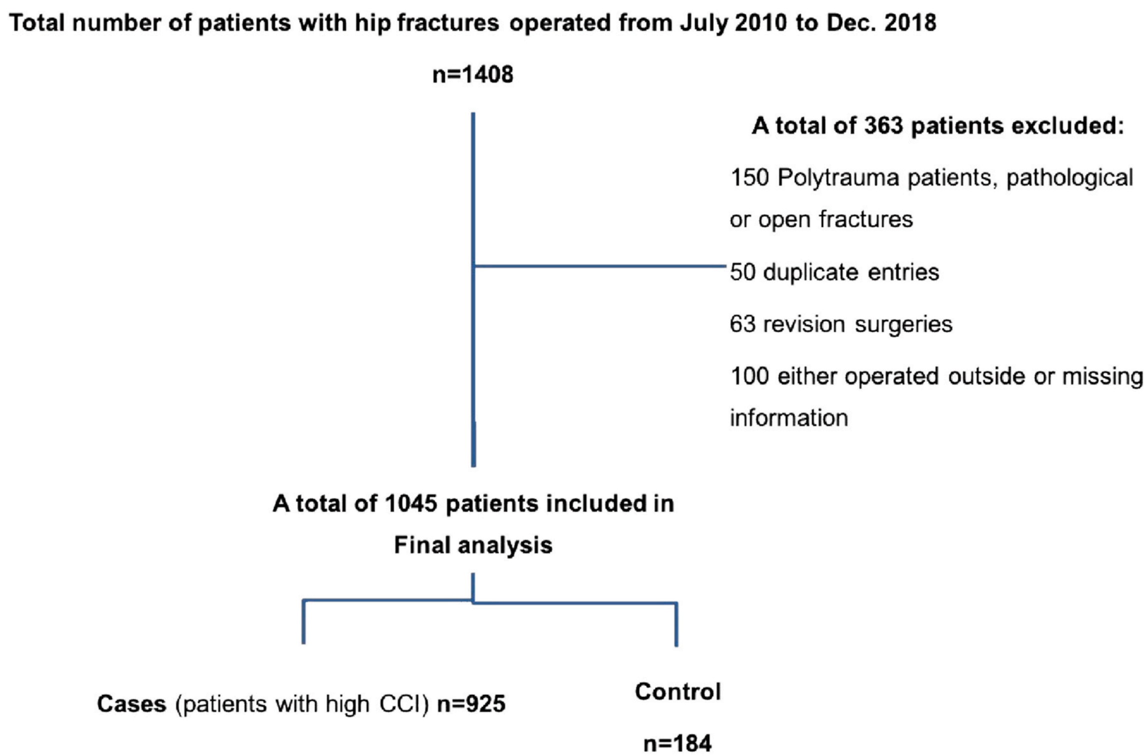

Fig. 1. Study flow diagram.

4. Discussion

We found a significant association of CCI score, ASA level and postoperative ICU admission with postoperative complications. Patients with high CCI score were 1.45 times at higher risk of developing postoperative complications as compared to patients with low CCI score, and those having a higher ASA level were 1.77 times more likely to develop postoperative complications as compared to patients with low ASA level. Moreover, we found that the patients who were admitted to ICU after hip surgery had a 1.61 times greater risk of developing postoperative complications as compared to patients who did not have an ICU admission. Our results were consistent with findings from several other published studies. Lin et al. assessed the risk factors for postoperative complications and mortality following hip surgery and found that CCI comorbidities were a significant risk factor for both mortality and postoperative complications and that greater number of CCI comorbidities had a higher risk of mortality and complications (patients with one and two or more CCI comorbidities had higher risk of complication compared with those with no CCI comorbidity). Moreover, Lin et al. stated that these post-operative complications resulted in 42.83% of patients receiving an internal fixation implant or prosthesis removal and 2.01% patients had to undergo revision arthroplasty during the 11-year follow-up [14].

Ondeck et al., a large study of 64,792 patients, studied the predictive effect of age, modified CCI and ASA score on postoperative complications after THA and, in concordance with our study, concluded that age and ASA score were significantly associated with postoperative complications. However, in contrast to our study, they reported that the modified Charlson Comorbidity Index was not very effective in predicting post op adverse events [15]. Lakomkin et al. studied the association of CCI with post op adverse effects in repeat hip surgery. In agreement with our study, they reported that higher CCI scores were significantly associated with major complications (severe events, including death, septic shock, coma, cardiac arrest, myocardial infarction, stroke, renal failure, use of a ventilator exceeding 48 h, wound infection, pulmonary embolism or deep vein thrombosis, unplanned intubation, or return to the operating room) and minor complications (renal insufficiency, pneumonia, and urinary tract infection). They also concluded that CCI was significantly associated with mortality after surgery [16].

Neuhaus et al., in a large study that included more than 6 million adult patients, explored the association of three different CCIs on post complications and mortality following hip surgery and, in concordance with other studies, reported an increased risk of mortality and in-hospital adverse events post-operatively with increasing age-adjusted CCI. However, they concluded that the accuracy of this model was poor [17].

Similar to other studies, Hindmarsh et al. reported an increased incidence of mortality with increasing CCI score, however, they did not find a clear association between comorbidities as measured by the CCI and peri- and post-operative complications [18].

Roche et al. reported on comorbidities and postoperative complications following hip surgery. They found that patients with three or more comorbidities on admission had a greater risk of postoperative complications and increased mortality [6]. A similar analysis performed by Lakomkin et al. studying association of pre op comorbids with post op adverse effects concluded that COPD, CHF, elevated ASA score and dyspnoea predisposed patients to a greater risk of developing postoperative complications after hip fracture surgery [19]. However, none of these studies assessed the relationship using CCI. Many studies only reviewed the effect of CCI on comorbidities and mortality. Kirkland et al. studied the association of CCI with 30-day postoperative mortality in elderly patients undergoing hip fracture surgery and concluded that there was a strong association of CCI score with postoperative mortality (a CCI score of $>/=6$ was associated with 30 day post op mortality) [20].

Other studies, Lau et al., Espinosa et al. and Toson et al., had similar findings. They concluded that CCI score adjusted for age was significantly associated with post op inpatient, 30-day (short term) and 1 year (long-term) mortality. However, they did not report on its significance

Table 1
Demographic and clinical characteristics of exposed and unexposed groups.

Variable	Exposed (n = 925)	Unexposed (n = 184)
Age (Years)[a] Mean ± SD	72.6 ± 9.38	42.0 ± 12.3
Gender[a]		
men	340 (39.5%)	120 (65.2%)
women	585 (60.6%)	64 (34.8%)
BMI		
Underweight	64 (7.4%)	9 (4.9%)
Normal	336 (39.0%)	71 (38.6%)
Overweight	341 (39.6%)	84 (45.6%)
Obese	120 (13.9%)	20 (10.8%)
Mechanism of Injury[a]		
Ground level fall	87 (47.3%)	97 (52.7%)
Others	794 (92.2%)	67 (7.7%)
Fracture Type[a]		
IT	460 (53.4%)	63 (34.2%)
NOF	361 (41.9%)	80 (43.5%)
Sub trochanteric	40 (4.7%)	41 (22.3%)
Duration of Surgery[a]		
<61 Minutes	131 (15.21)	22 (11.96)
61–120	548 (63.65)	89 (48.37)
>120	182 (21.14)	73 (39.67)
Admission in ICU[a]		
Yes	46 (5.3%)	2 (1.1%)
No	815 (94.7%)	182 (98.9%)
ASA Status[a]		
I	31 (3.6%)	55 (29.9%)
II	336 (39.0%)	95 (51.6%)
III	434 (50.4%)	32 (17.4%)
IV	60 (6.9%)	2 (1.1%)
Walking Status[a]		
Independent	183 (21.2%)	149 (81.0%)
Limited community	308 (35.8%)	24 (13.0%)
Walk with support	135 (15.7%)	5 (2.7%)
Limited home	232 (26.9%)	4 (2.2%)
Bedridden	3 (0.4%)	2 (1.1%)
Procedure[a]		
DHS	41 (22.3%)	66 (35.9%)
Bipolar Hemi.	85 (9.9%)	11 (6.05)
Monopolar	132 (15.3%)	4 (2.2%)
THR	106 (12.3%)	17 (9.2%)
IMN	30 (3.5%)	31 (16.8%)
Others	53 (6.2%)	55 (30.0%)

Abbreviations: CCI= Charlson Comorbidity Index; Mech. = Mechanism of Injury; IT=Intertrochanteric; NOF= Neck Of Femur; DHS = Dynamic Hip Screw; Hemi. = Hemiarthroplasty; THR = Total Hip replacement; IMN= Intramedullary Nailing.

[a] Significant with p value of ≤0.05. Proportions in the two groups are compared using Chi-square test and Wald $\chi 2$ test from Cox proportional algorithm model, while means±SDs and their p value by independent t-test.

Table 2
Unadjusted and adjusted HR of variables significant in Multivariable analysis.

Variable	Unadjusted RR (95% CI)	p-value	Adjusted RR (95% CI)	p-value
CCI[a]		0.04		0.021
Low (Ref)	1		1	
High	1.54 (1.14–2.06)		1.45 (1.05–1.99)	
ASA		0.01		0.025
1 (Ref)	1		1	
2	1.45 (0.92–2.26)		1.27 (0.79–2.02)	
3	1.70 (1.09–2.64)		1.41 (0.88–2.77)	
4	2.08 (1.21–3.56)		1.77 (1.09–2.23)	
ICU Admission		0.02		
No (Ref)	1		1	0.015
Yes	1.54 (1.06–2.25)		1.61 (1.10–2.37)	

[a] Primary exposure.

for assessing postoperative complications [21–23].

Jiang et al. reported that a greater age adjusted CCI was significantly associated with 5-year mortality. However, they did not report on post op complications [24]. Similarly, González-Zabaleta et al. reported on post op mortality and functional mobility in association with CCI and did not report other post op adverse events [25].

One of the major strengths of our study is that it is one of the first studies to be conducted in Pakistan (a developing country) assessing the relationship between CCI and postoperative complications. Furthermore, the study was conducted by a team of experts in orthopedic surgery, data collection, research methodology and biotechnicians. The comparative study design, including both groups, used inferential statistics to derive the conclusion.

Our study had a few caveats. First, it was a retrospective cohort study and therefore, there is a risk of selection bias which could not have been avoided. Secondly, we were not able to control for other potential confounding factors that might have affected our results, such as other comorbid conditions not accounted for by CCI, medications, smoking status of the patients, surgeon expertise and postoperative care of the patient by caregivers. Apart from that, we collected and reported the data from a single institution, which might not be representative of the whole country.

5. Conclusion

This retrospective cohort study of patients who underwent surgery for hip fractures provides evidence that the CCI can be used preoperatively to assess the burden of comorbidity that can affect postoperative outcomes of the patient. However, a prospective control study could be conducted in future to assess the association between CCI and postoperative complications.

Disclaimer

None.

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Nil.

Data statement

Corresponding author has no permission from the Aga Khan University to share the data. For further details or inquiries contact the corresponding author.

Declaration of competing interest

There are no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijsu.2020.08.017.

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