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ORIGINAL ARTICLE

Outcome of pubic rami fractures with or without concomitant involvement of the posterior ring in elderly patients

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Abstract

Introduction Pubic rami fractures are common fractures in a growing osteoporotic geriatric population. Concomitant posterior ring fractures (cPRF) are often found when properly looked for. The pain and consequent immobilization leaves this vulnerable patient group at risk for complications. Conservative therapy is usually sufficient, but with cPRF's surgery can be indicated. Although previous studies have pointed out that mortality rates are high, longer term morbidity outcomes are lacking. This study aims to further establish the longer term consequences of these fractures. Risk factors will be identified for complications, also addressing the possible differences between patients with or without a cPRF.

Method Retrospective analysis of patients aged over 65 years sustaining a pubic rami fracture in the North-West Hospital Group Alkmaar combined with a survey to establish risk factors for morbidity and mortality after 6 months' post trauma. Multiple logistic regression analysis was used to identify risk factors.

Results 117 patients matched inclusion criteria with a median age of 83 and of which 86% was female. 23 cPRF's were identified. Significant deterioration in ambulation and independency was found. 34% was institutionalized at discharge. 49% lost their independent mobility status and 40% of the patients did not experience a full recovery. One-year mortality rate was 23%. Patients with a cPRF had a significant higher complication rate (44 vs 18% $p=0.02$), but mortality and other morbidity outcomes did not statistically differ. The strongest predictor for 1-year mortality was complications during admission and a dependent ambulatory status (OR 5.2 and 4.1 respectively).

Conclusion Pubic fractures with or without involvement of the posterior pelvic ring in patients aged over 65 have a significant impact on mobility and independency. Mortality rates are similar to hip fracture patients. Careful evaluation of every patient's mobility status is necessary to identify patients at risk for complications and determine their future health care needs. Future studies are needed to achieve consensus on diagnostic and treatment protocols and identify ways to decrease the significant impact of this injury.

Keywords Pubic rami fracture · Elderly patients · Pelvic fracture · Posterior pelvic ring · Sacral fracture · Geriatric patients

Introduction

Pubic rami fractures are an underestimated injury that is frequently seen amongst elderly patients in the emergency department (ED). A sharp increase in osteoporotic pelvic fractures of 23% per year has been noted between 1970 and 1997 with this number expected to continue to rise until 2025 [1, 2]. The trauma mechanism of pelvic fractures in elderly patients often concerns a low energetic trauma in the form of a simple fall from standing height. These fractures differ from pelvic injuries seen in younger patients sustaining a high energetic trauma (HET), because of the lower strength of the bony structures compared to the surrounding ligaments in the elderly. Therefore, the combination of osseous and ligamentous injury as in (younger) HET patients is less frequently seen [3]. The term fragility fractures of the pelvis (FFP) is used for pelvic fractures in elderly patients.

Isolated pubic rami fractures, also referred to as anterior pelvic ring fractures (iAPRF), usually do not require surgical intervention. However, a concomitant posterior pelvic ring fracture, referred to as cPRF, is often found when properly looked for [3–7]. A cPRF can be considered as an unstable fracture that may benefit from surgical intervention [3].

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The difficulty lies in diagnosing cPRF's since they are not easily identifiable on the conventional pelvic radiograph due to generalized osteoporosis, overlying bowel shadows and vascular calcifications [8]. The number of sacral fractures detected on pelvic radiographs alone ranges from 0 to 10% [7]. CT is the preferred imaging modality for detecting cPRF's, but is not considered as a standard workup in pubic rami fracture patients. When CT-scanning is used as a standard, cPRF rates up to 80% are reported depending on the definition of the fracture [3]. Not always knowing the full extent of the fractures could be the reason why some patients experience unexplained prolonged pain and consequent debilitation during conservative treatment. Conservative therapy in FFP's could lead to progressive instability, non-union, and secondary insufficiency fractures causing more pain and immobilization. Complications of immobilization are seen in 20–58% of the FFP patients [7, 9, 10] with high mortality rates [10–12]. Therefore, operative intervention to prevent pain, immobilization, and consequent debilitation can be considered in a select group of patients with a cPRF [7].

The incidence, radiologic features, and mortality of pubic rami fractures with or without a cPRF have been well studied [4, 6, 10–16]. However, actual evidence on the subsequent (long-term) morbidity of pubic rami fractures is remarkably scarce despite the high impact on mortality. Alnaib et al. [4] have performed the only prospective study till date. Limitations of this and other retrospective studies describing morbidity are that they limit their follow-up to discharge, include HET patients and only focus on a limited number of outcome measurements (mortality and mobility or residential status) [3–5, 11, 14, 15, 17–19].

Until long-term patient-related outcome measurements will be better known, treatment protocols will be based on the experience of treating physicians. Currently, the consequences of pubic rami fractures and the excess impact of missed cPRF's cannot be established properly. A study cohort in which several longer term outcome measurements are established would provide new insights about the caused morbidity by pubic rami fractures in general that is not known till date.

This study aims to retrospectively review the longer term outcome of patients aged over 65 years sustaining a pubic rami fracture with or without a cPRF. The consequences of pubic rami fractures regarding diagnostic and therapeutic management will be further established. Risk factors for morbidity and mortality will be identified for this underestimated injury also focusing on the possible differences between patients with or without a cPRF.

Method

Consecutive patients aged over 65 years with a pubic rami fracture between 2014 and September 2016 were retrospectively included. These patients, if experiencing mobilization difficulties in the ED, were admitted short term on the trauma ward for mobilization with unrestricted weightbearing under supervision of a physiotherapist with adequate analgesia including opioids. Indications for a CT were difficulties in mobilization during the first few days of admission, pain in the posterior pelvic region, doubtful fractures on the pelvic radiographs, and suspicion of acetabular involvement. Pubic rami fractures featuring the anterior pubic root and non-intra-articular part of the acetabulum treated with unrestricted weight-bearing ambulation were considered pubic ramus fractures. Posterior pelvic ring involvement was defined as a fracture of the posterior ring on CT or MRI. Patients that did not undergo CT-scanning since the clinical suspicion of a cPRF was absent according to local hospital protocol were considered as iAPRF patients. Conservative treatment was the primary treatment of choice. The decision for operative treatment was made by the supervising trauma consultants, depending on patient and fracture characteristics. If indicated, patients were followed up on an outpatient basis. Patients sustaining a HET, a lower extremity fracture within the 6 months' follow-up or pathologic fractures, and patient referred to the outpatient clinic by other hospitals with a primary indication for surgery were excluded. Patients with a history of pelvic irradiation were included. Patient characteristics regarding age, sex, type of trauma, American Society of Anesthesiologists (ASA) scores, and results of imaging modalities were noted. Pelvic fractures were classified based on CT-imaging by an experienced trauma surgeon according to the classifications of Rommens, Tile(OTA), and Young and Burgess [3, 20, 21]. Only patients who underwent CT-scanning were subject to fracture classification. Primary endpoint was recovery to pre-trauma autonomy/mobility level. This was determined as return to pre-trauma residential, mobility (use of walking aids), independency status at home (measured by the level of home care received), and the patients experience of recovery in general and mobility. In addition, pain scores (Visual Analogue Score) were analyzed if available in nursing charts, length of hospital stay, complications during hospital stay, readmissions within 30 days, number of treatment alternations, mortality rates during admission, at 30 days, 90 days, 6 months, and 1 year were obtained. Data were collected by patient chart reviewing. Sample size calculation was not performed. An additional questionnaire or follow-up by phone was conducted to minimize missing data with regards to the primary end-points

as described above, after informed consent was obtained. The primary outcome measurements were determined at admission, discharge, and 6 months' follow-up.

Statistical analyses were performed based on the comparison of before and after measurements in and between patients for the different fracture types. 2 × 2 tables were analyzed by the chi-square or Fisher's exact test for unpaired dichotomous outcome measurements. For paired dichotomous data the McNemar test and for continuous outcome measurements the Mann–Whitney test were used to compare averages. A p value <0.05 was considered as statistically significant. A regression analysis for risk factors for 1-year mortality and return to original mobility status was performed.

Results

One-hundred seventeen out of 174 patients matched the inclusion criteria. The median age at the day of trauma was 83 (IQR [76–89]) with ASA scores increasing with age. All patient baseline characteristics are summarized in Table 1. There were no statistical differences at baseline between patients with an iAPRF and a cPRF. For an overview of the diagnostic and therapeutic management of the patients presented via the ED, see Fig. 1.

Diagnostic features

In 34 patients (29%), a CT-scan was performed (Fig. 1). In 23 of these patients (67%), a cPRF was confirmed (20% of the total cohort). A broad range of indications for the CT-scans was noted. In 68%, a CT-scan (22/34) was requested to confirm a suspected cPRF based on pain localization (9/34), limited mobilization or increase in pain (10/34) or due to a suspected cPRF on the pelvic radiograph (3/34). In ten patients, an acetabular ($n=3$), hip fracture ($n=4$), or a non-specified fracture ($n=3$), respectively, had to be ruled out. Two other patients suffered from persistent hypotension or a suspected abdominal problem. In 25% ($n=6$), a cPRF was found that was not initially clinically suspected based on the CT indication. The average time till additional CT-scanning during admission and follow-up was 2.7 (1–6) and 53 (35–64) days, respectively. Ten additional iAPRF's (9%) were diagnosed via CT that were not identified on the pelvic radiograph. Patients with known osteoporosis or risk factors for osteoporosis had a statistically higher chance of a cPRF (65 vs 35%, $p=0.02$). The fracture classification of the patient population is shown in Table 2.

Table 1 Patient characteristics

Characteristic	Total ($n=117$)	Characteristics	Total ($n=117$)
Age (years)		Trauma occasion	
65–74	23 (20%)	Private	85 (73%)
75–84	45 (39%)	Traffic (LET)	27 (23%)
85–94	46 (39%)	Sports	4 (3%)
>95	3 (3%)	Work	1 (1%)
Gender		Treatment basis	
Female	101 (86%)	Admission	78 (67%)
ASA-score		Outpatient	
I	14 (12%)	Time till ED visit	39 (33%)
II	45 (39%)		1.8 (0–31)
III	52 (44%)		
IV	6 (5%)		

Patient characteristics of 117 included patients

ASA American Society of Anesthesiologist, *LET* low energetic trauma

Therapeutic management

All patients ($n=116$) managed via the ED were primarily treated conservatively (see Fig. 1). One patient was referred via the outpatient clinic for a suspected cPRF after pelvic irradiation that was confirmed on a nuclear bone scan and the subsequent CT before eventually undergoing surgery. This patient was not included in Fig. 1.

Patients who had a cPRF had a significantly higher admission rate (78 vs 65%, $p=0.04$). 24% ($n=19$) of the 78 admitted patients developed complications (see Table 3). Seven patients were operated on. Four patients were operated on during the primary admission. Three others were initially treated conservatively after admission. 16 out 23 patients (70%) with a Rommens fracture type II or higher were treated conservatively. No postoperative complications or re-operations occurred in the operative treatment group. Patients with a cPRF were more likely to develop any or multiple complications during admission than iAPRF patients (44 vs 18%, $p=0.02$ and 28 vs 5%, $p=0.01$, respectively).

A consult with another specialty was requested in 45% of the admitted patients (35 of 78). In 26%, this concerned a consult of the geriatrics department. The average time in hospital was 5.5 days (1–15). Patients with a cPRF had significant longer length of stay compared to iAPRF patients (4.5 vs 9 days, $p=0.000$).

Five patients (4.3%) were re-admitted within 30 days after discharge. Two patients suffered from posterior pain and others were re-admitted because of venous thrombosis, pressure sores, or pulmonary infection. Two more patients were re-admitted within 6 weeks because of pain and respiratory problems. 46% of the patients were followed up on outpatient basis. 26 and 10% were discharged from outpatient follow-up after one or two visits, respectively. Eight patients (7%) required three or more visits of which six of the patients sustaining a cPRF.

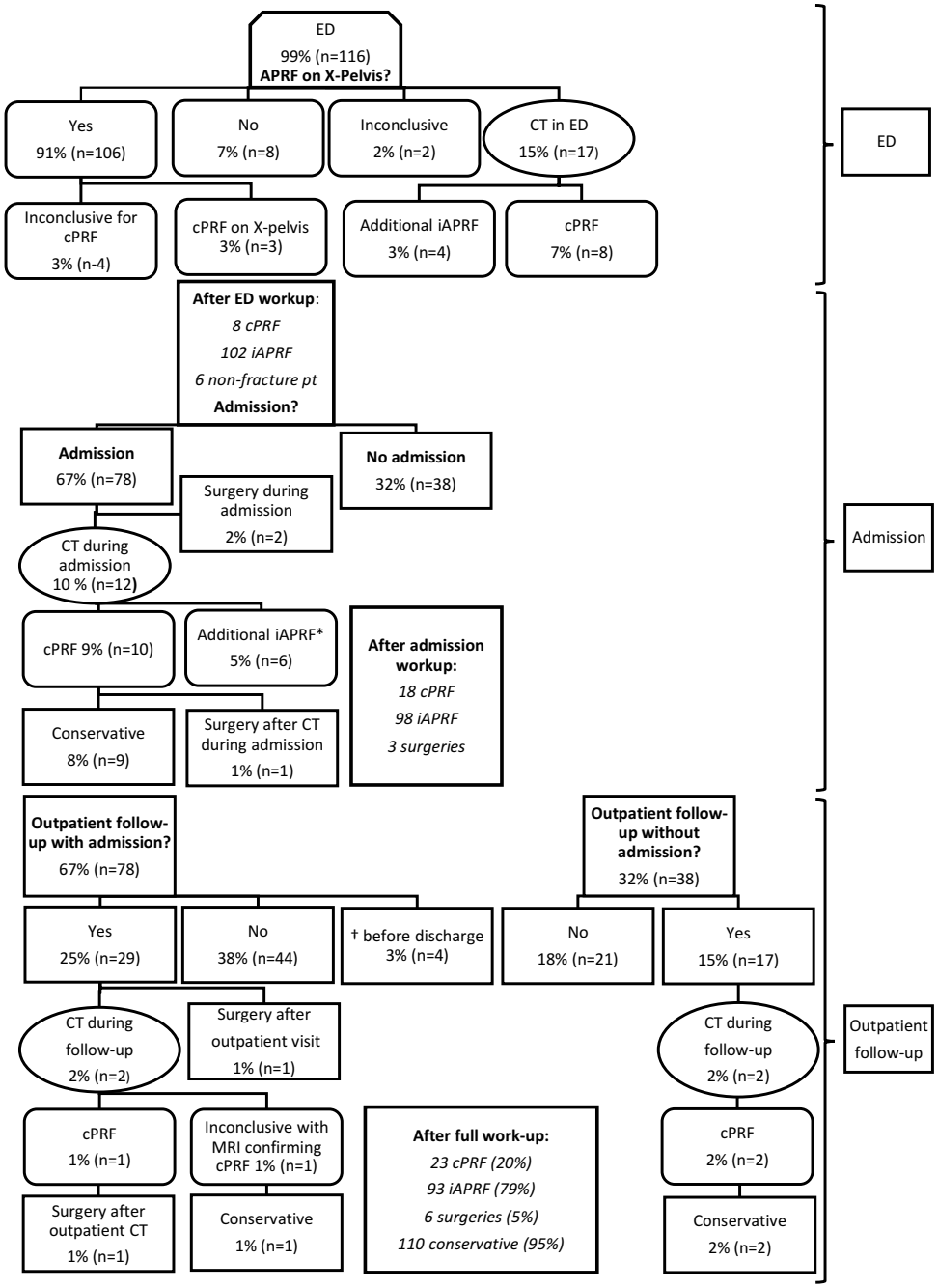

Fig. 1 Flowchart of diagnostic and therapeutic management of patients treated with a pubic rami fracture in the ED, during admission and on outpatient follow-up. All iAPRF's were treated conservatively. *ED* emergency department, *APRF* anterior pelvic ring fracture, *cPRF* concomitant posterior ring fracture, *iAPRF* isolated anterior pelvic ring fracture, *pt* patient. Dagger symbol: death, asterisk: additional iAPRF not previously diagnosed on the primary pelvic radiograph

Mortality

4 out of 78 admitted patients (5%) died during hospital stay. Three patients died because of respiratory complications and in one case the cause of acute death was unknown. For mortality rates during follow-up, see Table 4. No statistical difference was found between patients with or without a cPRF with regards to mortality at any point in time. Patient that developed a complication during hospital stay was statistically more likely to die at any point of time. For risk factors for 1-year mortality, see Table 5. A multivariate logistic regression model showed that a dependent ambulatory status (using a mobility aid) was the strongest predictor (OR 4.1) for 1-year mortality in general. If patients were admitted, complications during admission (OR 5.2) was the strongest predictor of 1-year mortality, followed by a dependent ambulatory status (OR 4.7). All of the patients (15/15) that were independently mobile at discharge were still alive at follow-up.

Table 2 Fracture classification ($n=34$)

Tile/OTA	$n=$	Young and Burges	$n=$	Rommens	$n=$
A2.2	11	LC1	13	1A	11
B2.1	10	LC2	10	2A	2
B2.2	5	LC3	1	2B	13
B2.3	2	AP1	1	2C	5
B3.2	2	Not classifiable	9	3C	3
B3.3	2				
C1.1	1				
C1.3	1				

Fracture classification of 34 patients involving a CT-scan (according to the classification of Tile/OTA, Young and Burgess, and Rommens et al. [3, 10, 11])

Table 3 Complications during admission

Patients ($n=19$)	n	%($n=34$)
Pneumonia	5	6
Urinary tract infection	5	6
Urine retention	5	5
Pressure sore(s)	3	4
Anemia requiring transfusion	3	4
Congestive heart failure	2	3
Delirium	2	3
Atrial fibrillation	1	1
Electrolyte disorder	1	1
Hypo/hyperglycemia	1	1
Death during admission	4	5
Total	34	

Overview of the 34 complications registered in 19 different patients out of 78 admitted patients. Eight patients (10%) developed multiple complications during admission

Mobility status

An overview of the ambulatory status at admission, discharge, and follow-up is shown in Table 6. 49% of the patients (23/47) who were independently mobile at admission used walking aids at follow-up. Patients that did not return to their pre-trauma mobility status needed a higher level of home care at follow-up than patients that did recover (50 vs 17%, $p=0.01$). 34% of the patients (21/62) experienced a limitation of their mobility at follow-up regardless of their pre-trauma ambulatory status. A recovery to the original mobility status was not affected by fracture type, gender, admission, or complications during admission. Mobility status at admission did not affect complication rates. Age did significantly affect a return to the original mobility status and the experience of a full recovery of the walking ability, with less return to the pre-trauma mobility with rising age. 24 out of 62 patients (39%) did not experience a full recovery in general. 21 of these 24 patients (34%) also stated that they experienced a decrease or difficulties in their walking ability.

Residency and independency status

For an overview of the residential status at admission, discharge, and follow-up, see Table 7. All four patients that died during admission lived un-institutionalized prior to the trauma. All patients that lived independently pre-trauma and developed complications during admission (9/9) were institutionalized at discharge. 35% of the patients (41/117) lived entirely independent (without living assistance) and un-institutionalized prior to the injury (see Table 8). 72% (41/57) returned to their previous independency status, with 27% of the patients (22/81) living entirely independent at follow-up, if they were still alive. Patients that already received home care minimally twice a day pre-trauma were less likely to return to their original residential status compared to patients receiving home care less than twice a day (70 vs 93%, $p=0.03$). The level of independency did not

Table 4 Mortality rates based on fracture type

	Mortality									
	During admission		30-days		90-days		6-months		1-year[a]	
	$n=78$	%	$n=117$	%	$n=117$	%	$n=117$	%	$n=117$	%
iAPRF (=94)	4	4	7	7	10	11	11	12	19	20
cPRF ($n=23$)	1	4	2	9	4	17	5	22	8	35
Total ($n=117$)	5	4	9	8	14	12	16	14	27	23

Mortality rates based on time of death since the ED visit. There was no statistical difference between time of death and patient with or without concomitant involvement of the posterior ring at any point of time

[a]105 patients were known to be death or alive at 1-year follow-up. 12 patients were considered alive; therefore, the 1-year mortality could be slightly underestimated

Table 5 Multivariate logistic regression analysis of risk factors for 1-year mortality after trauma

Characteristic	Total ($n=117$)		Admitted patients ($n=78$)	
	p value	OR	p value	OR
Age	0.31	1.042	0.29	1.053
ASA (> 2)	0.23	2.01	0.49	1.56
Institutionalized at admission	0.26	1.86	0.60	1.40
Dependent mobility status at admission	0.02	4.12	0.03	4.67
Complications during admission[a]	–	–	0.01	5.18

Risk factors for 1-year mortality of statistically significant univariate risk factors

[a]Only calculated for patients that were admitted

affect mortality at any point of time. Fracture type, age, gender, admission, and complications during admission did not influence the independency status or a return to the original residency.

Pain

The average level of pain in the ER or first hours during admission was 4 (0–9). The average VAS score at discharge from the trauma ward was 2 (0–6). The average difference in VAS score between admission and discharge was 2.5 points lower ($n=77$). Fracture type did not influence pain at any point of time. 32% of the patients (18/57) still experienced pain after 4 months' post discharge of which 16% suffered from pain longer than 6 months.

Discussion

This study is one of the first to describe multiple longer term outcomes relating pubic rami fractures. It demonstrates that pubic rami fractures in elderly patients, with or without a concomitant involvement of the posterior ring, cause significant morbidity and mortality. Significant deterioration in ambulation and independency is seen following these injuries with almost half of the patients

Table 6 Mobility status at admission, discharge, and 6 months' follow-up

Mobility	Admission		Discharge ED/trauma ward			Follow-up		
	$n=107$	%	$n=97$	%	RTOMS[b]	$n=70$	%	RTOMS
Total								
Independent	61	56	15	16	30% (16/53)	25	34	51% (24/47)
Stick	8	7	6	6	0% (0/7)	3	4	25% (1/4)
Frame	38	35	49	51	55% (18/33)	44	60	95% (19/20)
Wheelchair	1	1	3	4	0% (0/1)	–	–	0% (0/1)
Bed–chair[a]	1	1	23	24	100% (1/1)	2	3	–
Total	107	100	97	100	37% (35/95)	70	100	61% (44/72)

Mobility status prior to trauma, at discharge and at 6 months' follow-up. In 47 patients, the mobility status was unknown after 6 months of which 27 were deceased before follow-up

ED emergency department, *RTOMS* percentage of patients that return to their original mobility status

[a]Patient that were only able to mobilize between bed and chair

[b]9 patients (9%) had weight-bearing restrictions upon discharge for 4–6 weeks

Table 7 Residential status at admission, discharge, and 6 months' follow-up

Residence	Admission		Discharge ED/trauma ward			Follow-up		
	$n=117$	%	$n=113$	%	RTORS	$n=84$	%	RTORS
Total ($n=117$)								
Home	85	73	44	39	54% (44/81)	62	74	87% (62/71)
Residential home	13	11	10	9	54% (7/13)	10	12	80% (4/5)
Nursing home	17	15	20	18	100% (17/17)	11	13	100% (7/7)
Rehabilitation center	2	2	39	35	50% (1/2)	1	1	0% (0/1)
Total	117	100	113	100	61% (69/113)	84	100	87% (73/84)

Residential status prior to the trauma, at discharge and at 6 months' follow-up. In 33 patients, the residential status after 6 months was unknown of which 27 were deceased before follow-up

ED emergency department, *RTORS* percentage of patients that return to their original residential status, *home* un-institutionalized with or without home care

Table 8 Independency status when living at home

Home care	Admission		Follow-up		
	$n=83$	%	$n=60$	%	RTOIS
Total ($n=83$)					
Fully independent	41	49	22	37	59% (19/32)
≤ 1× a day	14	17	15	25	83% (10/12)
≥ 2 a day	28	33	22	37	92% (12/13)
Total	83	100	60	100	72% (41/57)

Independency status of patients living at home based on the level of home care received measured at admission and after 6 months' follow-up

RTOIS percentage of patient that return to their original independency status

not experiencing a full recovery after 6 months. Because of pain and mobility impairment, these frail patients are at risk for complications and death. Higher complication rates are seen in cPRF patients. A cPRF is often found when properly looked for, but often diagnosed with delay since detection rates of PRF's on pelvic radiographs are low and CT-imaging is not standard protocol in every hospital. Admission is an effective way to monitor the mobility status and adequately achieve analgesia for patients that are unable to mobilize in the ED. During admission, future health care needs can be determined and therefore reduce the risk of complications. However, admission does not seem indicated in patients with few comorbidities that are able to adequately mobilize in the ED. Proper mobilization seems to be the key to prevent complications, mortality, and improve patient satisfaction since a decrease in mobility was the most important factor for patient not experiencing a full recovery.

Previous studies describing outcomes in FFP patients also report this significant impact on patient mobility, but with the limitations as mentioned earlier. Hill et al., Lau et al., Maier et al., and Breuil et al. report a return to the original mobility status (dependent or independent) of 49–62% [5, 11], a return to original residential status (institutionalized or un-institutionalized) of 81–86% [10], a 100% increase of patients needing daily assistance [10], and loss of autonomy of 54% [15] after various follow-up periods with no individual study addressing more than two outcome measurements. The mortality rates in this study are similar to previous studies [5, 6, 11–16]. Significant excess mortality in institutionalized FFP patients during the first [hazard ratio (HR) 1.83] and second (HR 1.51) month post hospital admission is described [24], stressing the importance of proper health care post hospital discharge. In addition to the risk factors for mortality in this study, other studies also describe age, male gender, and dementia as independent predictors in iAPFR's [11, 22, 23].

It is remarkable that, although mortality rates in FFP patients are similar to those of hip fracture patients (15.8 and 24.5% for 6-month and 1-year mortality, respectively [24]), hip fracture patients have been extensively studied and research data of (similar) FFP patients are scarce. Since patient groups are very comparable, it can be suggested that FFP patients would also benefit from the multidisciplinary orthogeriatric approach that has proven to be successful in hip fracture patients [25]. Current treatment schemes are based on retrospective studies and physicians' experience. Prior to this study, longer term outcome data on elderly patients with pubic rami fractures were limited. The consequences of pubic ramus fractures are important to recognize not only to optimize diagnostic and treatment pathways, but also to properly inform patients and their relatives about the recovery period ahead in the context of expectation management.

Conservative therapy is the primary treatment of choice for iAPRF's and stable cPRF's [3, 7]. In some cPRF patients, operative intervention seems indicated. Rommens and Hofmann [3] strongly recommend operative intervention for type II fractures or higher. In this cohort, 70% of these patients were managed conservatively of which the larger part does recover well. Three (10%) patients required intervention after failed conservative treatment. We believe that surgery could provide better pain relief and early mobilization and therefore reduce complications in properly selected patients. This is based on a limited number of (small) prospective and few retrospective studies, and does require further evaluation [5, 26, 27]. Surgical treatment does cause additional risks, especially in elderly patients, as known from hip fracture surgery [24, 28]. Non-displaced sacral fractures can be treated with internal fixation by IS-screw placement, and it has been proven to provide significant pain reduction from day 2 post-surgery in all patients, but is also associated with material-related complications [29].

The difficulty lies in the early detection of cPRF's and identifying those patients at risk for complications that would benefit from surgery. A proposed imaging model by Wagner et al. suggests CT-scanning for every patient with a pubic rami fracture on the pelvic radiograph to check for a cPRF's [7]. Two key questions need to be addressed before this should be considered. First of all, is there a portion of the patients with a cPRF that is missed by current management protocols without standard additional imaging? And second, if so, are these 'missed' cPRF's clinically relevant to routinely diagnose?

The current hypothesis is that not all cPRF's have therapeutic consequences. Since a significant portion of these patients does recover with conservative therapy (70% in this cohort). Although, higher complication rates were seen in cPRF patients, no significant differences in recovery to previous mobility, independency status, and mortality were

found. This evidence is also supported by Taillandier et al. [30] and Maier et al. [10]. Höch et al. found a 20% survival advantage at 2-year follow-up in operative vs conservatively treated cPRF patients, but quality of life and pain scores did not significantly differ. The mortality difference could be explained by the 4.4-year age difference at baseline between the two groups [31]. In this cohort, mortality in cPRF patients does seem higher than in iAPRF's, although because of the relative low number of patients included in the cohort, not yet significantly.

Furthermore, it is questionable whether there are many cPRF's missed by pure clinical examination and history taking since PPV's of 86–91% were found in studies of Nüchtern et al. [18] and Alnaib et al. [4], that would make physical examination not inferior to the detection rate of CT-scanning.

Beside early identification of patients that could benefit from surgery, it could also be advocated that patients with a cPRF without a primary indication for operative intervention should endure a longer follow-up period to monitor these patients more closely because of progressive secondary insufficiency fractures [7]. It could also be argued that initial ambulation policies could be adjusted to partial weight-bearing to prevent these insufficiency fractures. With current research data, including data from this study, we believe that there is no conclusive evidence to state that early standard CT-scanning has therapeutic consequences for FFP patients, if managed appropriately, but prospective studies are lacking and maybe these questions cannot be answered definitively before further studies are conducted.

As demonstrated, optimizing the mobility in the first period post trauma in elderly FFP patients with or without a cPRF is crucial to reduce fracture-related mortality and complications [24]. Future prospective studies are necessary and should focus on the evaluation of current proposed management schemes and further explore the consequences of cPRF's and identify ways to decrease the significant impact of this injury. Until future prospective studies are conducted management will be based on the clinical experience of trauma/orthopedic surgeons and data from retrospective studies.

Limitations

As with many retrospective studies, a part of data is missing. The number of deceased patients also contributes to this. It was unknown how many patients were confused or suffered from delirium or dementia, which could influence the outcome of the history taking, subjective pain and follow-up data. Items in the questionnaire were not validated. As CT-scan was not performed in every patient, it is possible that some patients did have a cPRF's that was now classified as an iAPRF, resulting in bias. The interobserver variation of the different imaging modalities has not been taken into account. Although the patient cohort is relatively small, this study is one of the largest studies describing this specific patient population suffering from a simple fall, excluding high-energy trauma patients and therefore not biasing results while focusing on longer term patient-related outcome.

Conclusion

The burden of disease in elderly patients sustaining pelvic ring injuries is underestimated. Pubic rami fractures with or without involvement of the posterior pelvic ring in elderly patients cause significant deterioration in ambulatory and independency status. Mortality is similar to hip fracture patients. Careful evaluation of every patient's mobility status is necessary to identify patients at risk for complications and determine their future health care needs. Operative interventions can be indicated in properly selected patients with a concomitant fracture of the posterior ring, but prospective studies are scarce. Future studies are needed to achieve consensus on diagnostic and treatment protocols and identify ways to decrease the significant impact of this injury.

Compliance with ethical standards

Conflict of interest S. A. I. Loggers declares that he has no conflict of interest. P. Joosse declares that he has no conflict of interest. K. J. Ponsen declares that he has no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required.

Informed consent Informed consent was obtained from all individual participants included in the study.

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