Adherence to a femoral neck fracture treatment guideline

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Abstract

Purpose: In 2007 the Dutch Surgical Society published a clinical practice guideline for the treatment of hip fracture patients, based on the best available international evidence at that time. We investigated to what extent treatment of femoral neck fracture patients in the Netherlands corresponded with these guidelines, and determined differences in patient characteristics between the treatment groups.

Methods: All femoral neck fracture patients treated in 14 hospitals between February 2008 and August 2009 were included. Patient characteristics, X-rays, and treatment data were collected retrospectively.

Results: From a total of 1250 included patients 59% had been treated with arthroplasty, 39% with internal fixation, and 2% with a non-operative treatment. While 74% of the treatment choices complied with the guideline, 12% did not. In 14% adherence could not be determined from the available data. Arthroplasty was preferred over internal fixation in elderly patients with severe comorbidity, pre-fracture osteoporosis and a displaced fracture, that were ambulatory with aids pre-fracture (Odds Ratio, OR 2.2-58.1). Sliding hip screws were preferred over cancellous screws in displaced fractures (OR 1.9).

Conclusions: Overall guideline adherence was good. Most deviations concerned treatment of elderly patients with a displaced fracture, as well as implant use in internal fixation. Additional data, preferably with a higher scientific level of evidence, on these issues is needed in order to improve the guideline and to reinforce a more uniform treatment of these patients.

Introduction

Hip fractures are associated with 30% mortality at one year and a profound temporary, sometimes permanent impairment of independence and quality of life [1]. Worldwide, 4.5 million people are disabled of hip fractures yearly, with an expected increase to 21 million persons living with a disability by 2040 [2, 3]. Approximately 50% of all hip fractures are intracapsular fractures of the femoral neck [4]. These can be treated with a non-operative treatment, internal fixation or arthroplasty.

In 2007 the Dutch Surgical Society (NVvH) published a guideline on the treatment of hip fracture patients [5]. This guideline provides a decision tree for the treatment of femoral neck fracture patients (Figure 1). Decisions are based upon evidence-based patient and fracture characteristics, that are relevant in the Netherlands as well as internationally [4, 6-12]. The guideline reflects surgical guidelines and behavior in Europe, although the English guideline is more detailed, specially concerning arthroplasty [13].

There is consensus that patients with undisplaced fractures should be treated with internal fixation [4]. Surgeons also agree that femoral neck fracture patients with arthrosis, rheumatoid arthritis, or a pathologic fracture should be treated with arthroplasty, as these conditions are contraindications for internal fixation. Surgeons agree that elderly *(i.e.*, >80 years old) with a displaced fracture should receive arthroplasty as well.

There is no clear consensus on the treatment of younger patients with a displaced fracture [6, 7, 9, 10, 14-16]. From meta-analyses it is known that internal fixation may lead to lower infection rates, less blood loss, a shorter operative time, and possibly a decrease in mortality rate. In contrast, arthroplasty significantly reduces the revision surgery rate [9, 10, 17]. Therefore, it is generally recommended that internal fixation can be used in patients with limited comorbidity and a low ASA-score (American Society of Anaesthesiologists), who are

mobile, independent, and not cognitively disabled pre-fracture. Patients for whom the risk of revision surgery is considered too high should be treated with arthroplasty.

After arthroplasty or internal fixation has been decided on, the type of prosthesis (*i.e.*, hemi-arthroplasty or total hip arthroplasty) or internal fixation (most commonly sliding hip screw or cancellous screws) has to be selected. Again, there is no consensus and surgical preference may play a role [6, 18-22].

In summary, for some patient groups there is still a need to define if they will benefit from a specific treatment [10]. The guideline provided the best available evidence when developed in 2007. As it cannot provide level I evidence for all patients, we anticipated that surgeons may differ in their treatment of some patient subgroups.

The aim of this study was to determine the extent to which femoral neck fracture patients were treated in agreement with the national guideline. As the guideline states that treatment decision should be based upon patient and fracture characteristics, differences in these characteristics between the treatment groups were also determined.

Patients and Methods

Fourteen hospitals participated in this retrospective study. These sites participated in a multicenter randomized controlled trial, the FAITH trial (Fixation using Alternative Implants for the Treatment of Hip fractures, NCT00761813) and formed a femoral neck fracture research network. This network consists of general/trauma surgeons and orthopedic surgeons in four academic hospitals and ten large non-academic hospitals, as both treat femoral neck fractures in the Netherlands.

All consecutive femoral neck fracture patients treated in these hospitals between February 2008 and August 2009 were included. Patients who had been referred to another hospital were excluded. Patients were identified by searching the electronic hospital database for DBC-code (Diagnose Behandel Combinatie; Diagnosis Related Groups (DRG's)), ICD-codes (International Classification of Diseases, version 9/10), and surgical codes. The following data were collected:

- patient characteristics: age, gender, ASA-score, comorbidity (*e.g.*, dementia, arthrosis, malignancies, and cardiac and pulmonary disease), pre-fracture living status, pre-fracture use of aids, and additional injuries;
- fracture characteristics: Garden (*i.e.*, undisplaced versus displaced) and Pauwels (*i.e.*, 1-2 versus 3) classification;
- treatment: type of treatment, surgical delay, surgeon's specialization, quality of reduction and positioning of the implant in internal fixation, and FAITH-participation;

Fracture characteristics were assessed independently by two senior trauma surgeons (MJH and MHJV) from blinded preoperative, peroperative, and postoperative X-rays. They also assessed the quality of reduction and positioning of implants used using criteria as defined in the Dutch NVvH guidelines (Table 1). If two out of three criteria were met,

reduction and positioning were scored as ‘acceptable’. If the assessment was indecisive, a third trauma surgeon (GRR) independently reviewed the X-rays and reached a final decision.

Statistical Analysis

Analyses were performed using SPSS (version 16.0, SPSS Inc., Chicago, IL, USA).
In order to perform a quantitative analysis of the degree of guideline adherence, we identified the patient subgroups for whom the guideline gives a clear, unambiguous treatment advice (level 1-3). For each patient group with a guideline based treatment proposal (a, b,…, z), the total number of patients in this group were counted (n_a, n_b,…, n_z). Subsequently, the number of patients who actually received the proposed treatment were counted (y_a, y_b,…, y_z). The proportion of provided treatments that corresponded with the guideline recommendations was calculated using the formula: $((y_a + y_b + \ldots + y_z) / (n_a + n_b, \ldots + n_z)) \times 100\%$.

Using similar calculations, the proportion of treatments for which adherence was unclear was reported. Guideline adherence was considered unclear if the treatment seemed in contradiction with the guideline, but could have been explained by a patient characteristic that was not collected in this study (*e.g.*, coxarthrosis or a pathological fracture).

Different treatment groups were compared; non-operative versus operative treatment, internal fixation versus arthroplasty, cancellous screws versus sliding hip screw, and hemi-arthroplasty versus total hip arthroplasty.

Continuous variables are presented as medians with interquartile ranges, categorical variables as numbers and percentage. Continuous variables were compared using the Mann-Whitney U-test. Categorical variables were compared using the Chi-squared test. A P-value <0.05 (two-sided) was taken as threshold of statistical significance. A multivariable logistical regression analysis using a forward stepwise approach was performed in order to model the relation between patient and fracture characteristics, and the treatment group. Variables that

displayed a P-value <0.1 in univariate analyses and variables which are likely to influence outcome were entered as covariate.

From this study population 194 patients also participated in the FAITH trial. They were randomized between a treatment with sliding hip screw or cancellous screws. Entering 'FAITH participation' as covariate into the regression model had no statistically significant effect on the results. The FAITH patients were therefore not excluded from analyses.

Results

Demographic description of patient, fracture and treatment characteristics

A total of 1355 femoral neck fracture patients were identified. Pre-operative or post-operative X-rays could not be retrieved for 105 patients; these were therefore excluded. The remaining 1250 patients were studied; 22 patients (2%) had been treated with a non-operative treatment, 486 (39%) with internal fixation, and 742 (59%) with arthroplasty. Of the internal fixation patients 290 (60%) had been treated with cancellous screws (CS) and 196 (40%) with a sliding hip screw (SHS). Of the arthroplasty patients 731 (99%) had been treated with a hemi-arthroplasty (HA) and 11 (1%) with a total hip arthroplasty (THA).

Non-operatively treated patients were significantly more often demented, had more often undisplaced fractures, and less often Pauwels 3 fractures, than surgically treated patients. Internal fixation patients were in a better condition than arthroplasty patients; younger, lower ASA-scores, had lower rates of comorbidity, known osteoporosis, medication use, dementia, and pre-fracture aided mobility, and a higher rate of independent living pre-fracture. Internal fixation patients were also less likely to have displaced fractures and Pauwels 3 fractures (Table 2).

Within the internal fixation group the SHS group was significantly older than the CS group, more often demented, and had more often known arthrosis (in other joints). Nevertheless, fewer SHS patients lived independently pre-fracture. In contrast, the CS group had lower ASA-scores, was less likely to have rheumatoid arthritis and osteoporosis, and had displaced fractures more often.

Within the arthroplasty group the THA patients were in a better condition than the HA patients. They were significantly younger, had lower rates of dementia, medication use, or

pre-fracture aided mobility. However, they had a higher rate of arthrosis and osteoporosis pre-fracture.

Treatment characteristics were also compared (Table 2). There were differences in the treatment received in academic hospitals (compared with non-academic hospitals) and in the treatment performed by general/trauma surgeons (compared with orthopedic surgeons).

Guideline adherence

Figure 2 shows the patient numbers in the different treatment groups. We identified the patient groups for whom the guideline gives a clear, unambiguous treatment advice.

Undisplaced fractures should be treated either with internal fixation or non-operatively. Of 322 patients with an undisplaced fracture, 247 had been treated with internal fixation, 59 with arthroplasty, and 16 non-operatively.

Patients with a displaced fracture should receive internal fixation if they are 65-80 years, ambulatory and have an ASA-score<3. These characteristics were present in 195 patients, 79 of whom had been treated with internal fixation, and 116 with an arthroplasty. Patients with a displaced fracture aged 65-80, who have an ASA-score>2 should receive an arthroplasty. Of 82 patients with these characteristics, 64 had been treated accordingly, and 18 had been treated with internal fixation. Arthroplasty should also be performed in patients aged >80 years with a displaced fracture. Of 511 patients with these characteristics, 465 were treated with an arthroplasty, 42 with internal fixation and four with a non-operative treatment.

If internal fixation is chosen for a Pauwels 3 fracture, the guideline recommends using a SHS. Of 171 Pauwels 3 internally fixated fractures, 77 received SHS and 94 CS.

In conclusion, of all treatments that could be quantitatively analyzed for guideline adherence, 74% corresponded with the guideline (Calculation: ((247+16+79+64+465+77)/(322+195+82+511+171))*100%). In 26% the treatment deviated

from the guideline. However, in 13% it could not be determined whether the treatment choice could have been explained by a characteristic that was not collected in this study (*e.g.*, coxarthrosis or a pathological fracture). In addition, 37 internal fixation patients with an unacceptable reduction were not converted to arthroplasty, and 45 internal fixation patients had an unacceptable implant position. In total, 72 internal fixation patients did not receive an acceptable treatment (15%).

Differences in characteristics between the treatment groups

Patient and fracture characteristics that independently influenced the treatment decision were studied using multivariable logistic regression models. Compared with internal fixation, patients had a greater chance of receiving an arthroplasty if they were older, had severe comorbidity (ASA-score>2) or osteoporosis diagnosed pre-fracture, a displaced fracture, were mobile pre-fracture using an aid, or if they had been treated by an orthopedic surgeon (Odds Ratio (OR) 2.2-58.1, Table 3). Patients receiving an arthroplasty were more often aged >80 years and had a higher odds of displaced fractures (OR 51.8 and 58.1, Table 3).

In internal fixation patients, a SHS was preferred over CS in patients with displaced fractures (OR 1.9; 95% CI 1.1-3.1, P=0.021), if they were treated in an academic hospital (OR 2.4; 95% CI 1.0-5.7, P=0.041). CS were preferred by orthopedic surgeons (OR 0.4, 95% CI 0.1-0.9, P=0.037).

Discussion

Guideline adherence

Overall guideline adherence was considered well, as 74% of the treatments corresponded. Deviations mainly concerned the treatment of elderly patients with a displaced fracture. Although the guideline recommends arthroplasty for patients aged 65-80 years with a displaced fracture and severe comorbidity (*i.e.,* ASA score>2), 22% of these patients were treated with internal fixation. In an international survey 6-26% of the surgeons preferred internal fixation for these patients as well [6]. In addition, 8% of patients aged >80 years with a displaced fracture were treated with internal fixation, whereas the guideline advises arthroplasty. The lack of convincing, irrefutable evidence on the treatment of these patient subgroups is reflected in our results [6, 7, 14]. A second reason for treatment inconsistency could be the shifting age limit for internal fixation of elderly with displaced fractures in the last decade. Traditionally, an age of 65-75 years was considered a fixed limit for using internal fixation. Now it has progressed to 80 years (in fit, healthy patients). Finally, some surgeons feel that internal fixation should be an acute treatment in all patients. A secondary arthroplasty, if necessary, can then be performed in a planned setting. This strategy may reduce the revision surgery, as the patients condition can be optimized pre-operatively.

Although the guideline suggests the use of sliding hip screws for Pauwels 3 fractures, 53% of these fractures in our study were treated with cancellous screws. Clearly, there is no agreement on implant selection for the treatment of sheer fractures. Since surgeons were not interviewed we do not know how many surgeons used the Pauwels classification in their decision making.

Patient and fracture characteristics

Our data showed that characteristics that surgeons consider when deciding on a treatment are age and fracture displacement in particular, but also comorbidity, pre-fracture diagnosed osteoporosis and pre-fracture mobility. These characteristics are compliant with the guideline [8, 17, 23]. Other characteristics that should be considered are dementia and pre-fracture living status [8, 9, 11, 23, 24]. These characteristics did not influence treatment in this study.

Orthopedic surgeons favored arthroplasty more often than general/trauma surgeons did. Orthopedic surgeons may have more affinity with arthroplasty, as they perform arthroplasties more often (*e.g.*, for arthrosis). Moreover, in the Netherlands total hip arthroplasties are performed by orthopedic surgeons only. Although it is comprehensible to perform a treatment that one is comfortable with, patient outcome should come first. Likewise, the treatment should not differ between academic and non-academic hospitals.

The strength of this study is the inclusion of a large, representative population. Participating surgeons represent both orthopedic and trauma/general surgeons in academic and non-academic hospitals in five different trauma regions nationwide. The guideline that was studied, is based on the best available international evidence at the time of development, and is therefore applicable internationally. Our results may stimulate others to perform similar research, as there are no guideline adherence studies concerning hip fracture treatment available at this moment, to the best of our knowledge.

Obviously, this study has limitations. The retrospective nature made it difficult to collect data on some characteristics that probably affected treatment decision (*e.g.*, pathological fracture, osteoarthrosis, or rheumatoid arthritis). However, as these characteristics are considered absolute contraindications for internal fixation, we expect that all surgeons provided the indicated treatment in these specific patients. A second limitation is the Pauwels classification assessment. It is known that the inter-observer agreement of the

Pauwels classification on pre-operative X-rays is low [25]. All X-rays were assessed in duplicate in order to obtain the highest reliability possible. Finally, there was unfortunately no option to question the surgeons about their motivation to deviate from the guideline.

In summary, overall adherence to the guideline for femoral neck fracture treatment was good, as 74% of the treatments corresponded. Most deviations concerned the treatment of elderly (age 65-80 years and >80 years) with a displaced fracture, and the implant choice in internal fixation. Additional data, preferably with a higher scientific level of evidence is needed in order to improve the guideline and to reinforce a more uniform treatment of these patients [10].

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Tables

Table 1. Criteria for acceptable reduction and positioning of the implant for internal fixation of a femoral neck fracture, according to Dutch NVvH guideline (5)

Acceptable reduction	Varus-valgus dislocation: maximum Garden index: 160–180° [+]
	Femoral neck shortening neutralized[+]
	Dorsoventral dislocation: maximum 10° retroversion - 5° anteversion[++]
Acceptable position cancellous screws	One screw placed caudally over the calcar femoris[+]
	One screw placed over the dorsal cortex[++]
	Screws positioned into the subchondral bone (maximum distance between screw tip and femoral head lining: 5-10 mm)[+]
Acceptable position sliding hip screw	Screw positioned in the central or caudal 1/3 part of femoral head[+]
	Screw positioned in the central or dorsal part of femoral head[++]
	Screw positioned into the subchondral bone (maximum distance between screw tip and femoral head lining: 5-10 mm)[+]

[+] On AP (Anterior-Posterior) view. [++] On axial view.

Table 2. Patient, fracture, and treatment characteristics

	Total N=1250	**Non-operative* N=22**	**IF** N=486**	**Arthroplasty N=742**	**CS*** N=290**	**SHS N=196**	**HA**** N=731**	**THA N=11**
Age[1] (years)	81 (72-87)	81 (70-89)	72 (60-81) [D]	84 (79-88)	75 (62-84) [D]	68 (56-78)	85 (80-88) [D]	62 (51-77)
Gender[2] (female)	804 (64)	18 (82)	264 (54) [D]	522 (70)	159 (55)	105 (54)	517 (71)	5 (46)
ASA-score[2] (ASA>2)	383 (31)	11 (50)	59 (12) [D]	313 (42)	33 (11) [A]	26 (13)	309 (42)	4 (36)
Comorbidity[2]	959 (77)	16 (73)	316 (65) [D]	627 (85)	186 (64)	130 (66)	618 (85)	9 (82)
Pulmonary disease[2]	124 (10)	2 (9)	48 (10)	74 (10)	29 (10) [B]	19 (10)	74 (10)	0 (0)
Cardiac disease[2]	329 (26)	3 (14)	104 (21) [C]	222 (30)	70 (24) [C]	34 (17)	222 (30) [A]	0 (0)
Hypertension[2]	303 (24)	3 (14)	96 (20) [B]	204 (28)	49 (17) [C]	47 (24)	201 (28)	3 (27)
Diabetes[2]	153 (12)	1 (5)	51 (11)	101 (14)	34 (12) [C]	17 (9)	101 (14)	0 (0)
CVA/TIA[2]	176 (14)	3 (14)	52 (11)	121 (16)	30 (10) [B]	22 (11)	121 (17)	0 (0)
Malignancy (past and present)[2]	184 (15)	5 (23)	61 (486) [A]	118 (16)	36 (12) [B]	25 (13)	117 (16)	1 (9)
Dementia[2]	238 (19)	9 (41) [A]	42 (9) [D]	187 (25)	31 (11) [B]	11 (6)	187 (26) [A]	0 (0)
Arthrosis pre-fracture[2]	67 (5)	1 (5)	20 (4)	46 (6)	13 (5) [B]	7 (4)	43 (6) [C]	3 (27)

Rheumatoid arthritis[2]	35 (3)	0 (0)	12 (3)	23 (3)	5 (2) [C]	7 (4)	23 (3)	0 (0)
Osteoporosis pre-fracture[2]	77 (6)	1 (5)	22 (5) [A]	54 (7)	11 (4) [A]	11 (6)	50 (7) [D]	4 (26)
Medication[2]	921 (74)	17 (77)	311 (64) [D]	593 (80)	183 (63)	128 (65)	588 (80) [C]	5 (46)
Additional injuries[2]	61 (5)	1 (5)	29 (6)	31 (4)	18 (6)	11 (6)	31 (4)	0 (0)
Pre-fracture living status[2] (independent)[§§]	700 (56)	12 (55)	362 (75)	326 (44)	204 (70)	158 (81)	320 (44)	6 (55)
No data available	263 (21)	2 (9)	62 (13) [D]	199 (27)	45 (16) [A]	17 (9)	195 (27)	4 (36)
Pre-fracture use of aids[2]	171 (14)	5 (23)	39 (8)	127 (17)	24 (8)	15 (8)	127 (17)	0 (0)
No data available	766 (61)	13 (59)	232 (48) [D]	521 (70)	148 (51)	84 (43)	514 (70) [A]	7 (64)
Garden classification[2] (displaced)	927 (74)	6 (27) [D]	239 (49) [D]	682 (92)	124 (43) [C]	115 (59)	673 (92)	9 (82)
Pauwels classification[2] (Pauwels 3)	492 (39)	3 (14) [A]	171 (35) [D]	318 (43)	94 (32)	77 (39)	312 (43)	6 (55)
Hospital[2] (academic)[§]	154 (12)	6 (27) [A]	71 (15) [A]	77 (10)	31 (11) [C]	40 (20)	73 (10) [C]	4 (36)
Surgical delay[1] (days)	1 (0-1)	N.A.	1 (0-1) [D]	1 (0-1)	1 (0-1)	1 (0-1)	1 (0-1) [A]	2 (1-6)
Surgeon[2] (general or trauma)[§§]	1005 (80)	19 (86) [D]	425 (87) [D]	561 (76)	242 (83) [C]	183 (93)	561 (77) [D]	0 (0)
Surgery performed by[2] (resident)[§§§]	775 (62)	N.A	347 (71) [D]	428 (58)	217 (75)	130 (66)	426 (58) [A]	2 (18)
Reduction[2] (unacceptable)	N.A.	N.A.	37 (8)	N.A.	28 (10) [A]	9 (5)	N.A.	N.A.

Positioning implant[2] (unacceptable)	N.A.	N.A.	45 (9)	N.A.	27 (9)	18 (9)	N.A.	N.A.

IF, Internal Fixation; CS, Cancellous screws; SHS, Sliding Hip Screw; HA, Hemi-Arthroplasty; THA, Total Hip Arthroplasty; CVA, Cerebro Vascular Accident; TIA, Transient Ischemic Attack; N.A., Not applicable

Unavailable data are only presented for variables that had ≥10% unavailable data in any group. Exception: in the THA group data were missing in two patients (18%) for all variables concerning comorbidity.

* P-values are presented for the comparison of non-operative therapy with surgery. ** P-values are presented for the comparison of internal fixation with arthroplasty. *** P-values are presented for the comparison of CS with SHS. **** P-values are presented for the comparison of HA with THA.

[A] $P<0.05$, [B] $P<0.01$, [C] $P<0.005$, [D] $P<0.001$. Non-significant P-values are not presented. The Mann-Whitney U-test was used for continuous variables, the Chi-squared test for categorical variables.

[1] Data are presented as median with P_{25}-P_{75} given between brackets. [2] Data are presented as number with percentages.

[§] As opposed to non-academic hospital. [§§] As opposed to orthopaedic surgeon. [§§§] As opposed to surgeon. However, >80% of these operations were supervised by a surgeon.

Table 3. Odds Ratios for the relation between patient and fracture characteristics, and choice of treatment: internal fixation versus arthroplasty

Determinant		**Odds Ratio (95% CI)**	**P-value**
Age group	0-65 years	Reference	
	66-80 years	5.6 (2.5-12.8)	<0.001
	81-100 years	51.8 (18.9-142.2)	<0.001
ASA score	ASA 1-2	Reference	
	ASA 3-4	7.4 (3.0-18.4)	<0.001
Osteoporosis pre-fracture	No	Reference	
	Yes	3.1 (1.0-9.6)	0.045
Pre-fracture mobility	No aids	Reference	
	Using aids	2.2 (1.0-4.7)	0.048
Garden classification	Garden 1-2 (undisplaced)	Reference	
	Garden 3-4 (displaced)	58.1 (20.9-161.2)	<0.001
Surgeon	General or trauma	Reference	
	Orthopaedic	4.2 (1.8-10.1)	0.001

Multivariable logistic regression model, using a forward stepwise approach.

An Odds Ratio>1.0 implies a greater chance of receiving arthroplasty.

Variables not included in the final model were hospital type, gender, arthrosis pre-fracture, rheumatoid arthritis, dementia, medication, pre-fracture living status, and Pauwels classification.

Figures

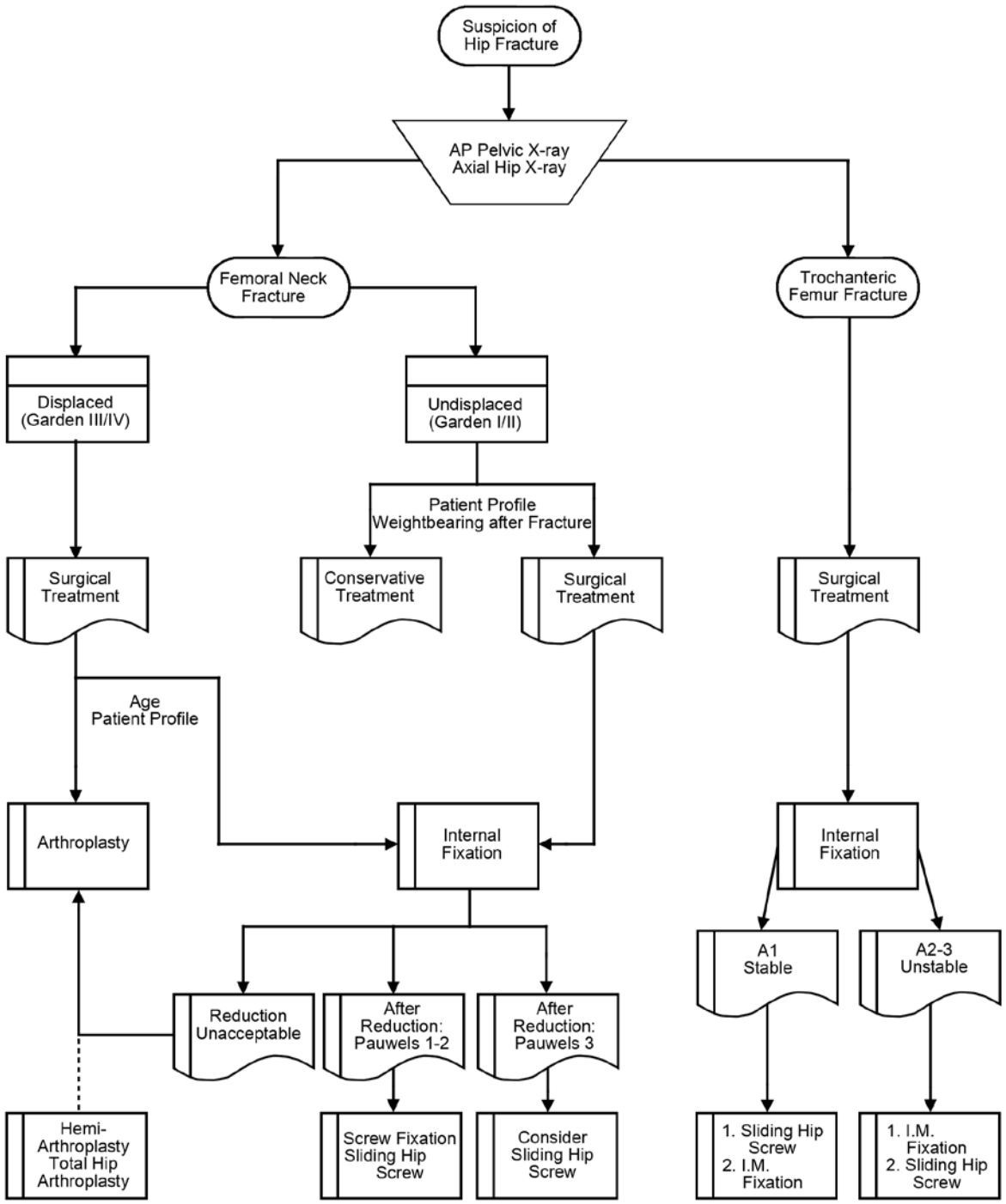

Figure 1. Decision tree for the treatment of hip fracture patients, from the NVvH richtlijn: Behandeling van de proximale femurfractuur bij de oudere mens (Guideline: Treatment of the proximal femoral fracture in the elderly person) [5]

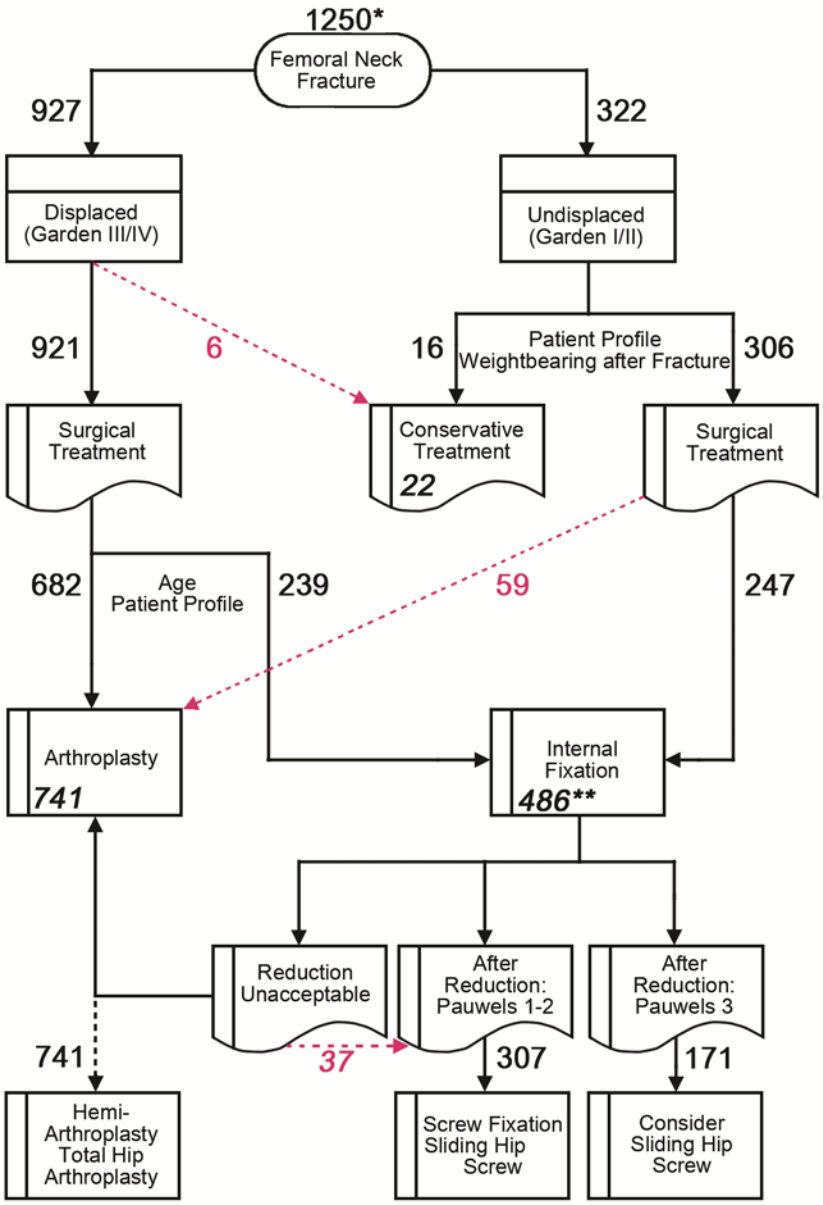

Figure 2. Decision tree for the treatment of femoral neck fracture patients, from the NVvH richtlijn: Behandeling van de proximale femurfractuur bij de oudere mens (Guideline: Treatment of the proximal femoral fracture in the elderly person) [5]. Patient numbers are shown.

* Garden classification could not be determined for one patient. **Pauwels classification could not be determined for eight patients. The decision tree could not be completed for these patients.

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