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Reliability of the AO group and Garden's classification system of femoral neck fractures in the assessment of fracture with or without displacements

Pouzdanost AO grupe i Garden klasifikacije prijeloma vrata bedrene kosti kod procjene prijeloma sa ili bez koštanog pomaka

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Summary

Aim: To determine the degree of clinical reliability and repeatability of the classification systems for neck femoral fractures according to the AO group and Garden estimate of fracture on the fractures with or without displacement according to the coefficient kappa value indispensable in the choice of treatment methods.

Methods: Five observers classified 70 randomly selected anterior-posterior (AP) and lateral view preoperative radiographs of femoral neck fractures according to the AO group and Garden's classification systems. The procedure was repeated on the same radiographs after three months. The first classification was used to calculate the inter observer agreement by kappa value between observers, while the first and second classification served to calculate the kappa value for each examiner.

Then we set fractures without displacement by AO group B1 and by Garden I+II and fractures with displacement to the AO group B2 + B3 and Garden III+IV.

With the same statistical method we have determined the kappa coefficient value for inter observer and intra observer agreement for such as a reduced form classification system of femoral neck fractures.

Results: The overall mean value for the classification system for inter observer agreement is: AO K = 0.48, Garden K = 0.42 Mean intra observer agreement for AO group K = 0.55, Garden K = 0.50 coefficient kappa value. The overall mean for reduced form classification system for inter observer agreement is: reduced form of AO K = 0.69, reduced form of Garden K = 0.57 Mean intra observer agreement for reduced form AO group K = 0.68, reduced form Garden 0.74 coefficient kappa value (K) ($p < 0.05$).

Conclusion: The Garden and AO group are the only ones useful for the division of femoral neck fractures without displacement and with displacement. To determine the methods of femoral neck fracture treatment, a reduced form of Garden´s classification system or reduced form of AO group is more reliable than the Garden or AO group classification system.

Key words: femoral neck fractures; AO group classification system for femoral neck fractures; Garden's classification system; kappa statistics; predict of treatment

Sažetak

Cilj: odrediti stupanj kliničke pouzdanosti i ponovljivosti klasifikacijskih sistema za prijelom vrata bedrene kosti prema AO i Gardenovoj podjeli prijeloma na prijelome sa i bez koštanog pomaka određivanjem kapa koeficijenata neophodnih za izbor načina liječenja.

Metode: Pet ispitivača klasificirali su nasumice odabranih 70 predoperativnih radiograma prijeloma vrata bedrene kosti prema AO i Gardenovom klasifikacijskom sistemu. Istovjetna procedura na istim radiogramima ponovljena je nakon tri mjeseca. Prvi postupak klasificiranja korišten je za izračun kapa vrijednosti između ispitivača, dok je prvi i drugi klasifikacijski postupak korišten sporazumno između ispitivača za izračun kapa vrijednosti za svakog pojedinačnog ispitivača.

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U prijelome bez koštanog pomaka svrstali smo, prema AO grupi B1, a po Gardenu I i II stupanj, a u skupinu prijeloma s koštanim pomakom prema AO grupi B2 i B3, a prema Gardenu III i IV.

Jednakom statističkom metodom odredili smo kapa koeficijent sporazumno između ispitivača za tako umanjeni oblik klasifikacijskog sustava prijeloma vrata bedrene kosti.

Rezultati: Srednja prosječna vrijednost za klasifikacijske sisteme za sporazum između ispitivača jesu: AO K = 0,48, Garden K = 0,42. Srednja vrijednost za sporazumne pojedinačne ispitivače je za AO grupu K = 0.55, Garden K = 0,50 koeficijent kapa vrijednosti. Srednja prosječna vrijednost za reducirane oblike klasifikacijskih sistema između ispitivača jesu: reducirani oblik AO grupe K = 0,69, a za reducirani oblik Gardena je K = 0,57. Srednja vrijednost za pojedinačne ispitivače je za reducirani oblik AO grupe K = 0,68, a reducirani oblik Gardena je 0,74 koeficijenta kapa vrijednosti ($p < 0,05$).

Zaključak: Garden i AO grupa jedino su korisni za podjelu prijeloma vrata bedrene kosti na prijelome bez ili sa koštanim prijelomom. Za određivanje metode liječenja prijeloma vrata bedrene kosti, reducirani oblik Gardenove klasifikacije ili reducirani oblik AO grupe, pouzdaniji su od Gardenove ili AO klasifikacije.

Ključne riječi: prijelomi vrata bedrene kosti, AO grupa klasifikacije prijeloma vrata bedrene kosti; Gardenov sustav klasifikacije; kappa statistika; predviđanje liječenja

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Introduction

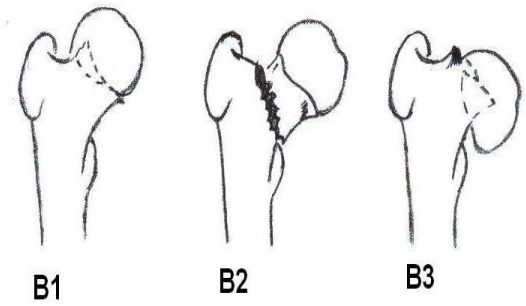
The studies of the inter and intra observer agreement classification systems for neck femoral fractures according to AO, Garden and Pauweles shows low values of the kappa coefficient calculated according to Flaiss's statistical method for rates and proportions.[1-11]

With such low values of inter and intra observer agreement the synchronization is questionable in determining the methods of treatment for femoral neck fractures.

To determine the methods of femoral neck fractures treatment it is necessary to reliably estimate the level of bone displacement.

The primary therapy is the same for the femoral neck fractures type without bone displacement – osteosynthesis. For the femoral neck fracture with displacement, treatment depends on the patient's age. Closed reduction and internal fixation is adequate for patients under 65 years of age. Patients between 65 and 75 years of age should be treated either with internal fixation or with a total hip prosthesis. Partial hip replacement should be reserved only for patients with life expectancy under one year. In some cases of fracture without dislocation, therapy can also be conservative. The biological age should also be taken in consideration in the selection of implants. Under biological age we mean the ASA-score, habitat, the activity level and the need for walking aids and cognitive function.[12-17]

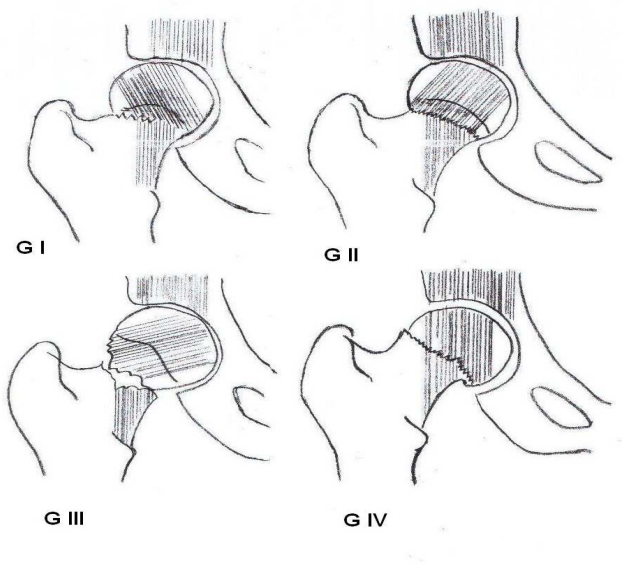
The main activity by the analysis of the fracture radiogram with the usage of the AO or Garden's classification systems is to determine whether the fracture is with or without displacement, Picture 1.



Picture 1a. AO group classification system of neck femoral fractures
Slika 1a. AO grupa klasifikacije sustava prijelom vrata bedrene kosti

Picture 1a: AO group classification system: B1 – without displaced fractures, B2 – transcervical fractures, type of fracture with high potential of displacement, B3 – with displaced subcapital fractures; Picture 1b: Garden's classification GI – inferior cortex is not completely broken, but the trabeculae are angulated, GII – fracture line is complete, trabecular lines are interrupted but are not angled, GIII – fracture line is obviously complete, rotation of the femoral head in acetabulum, trabeculare lines are interrupted and angled, GIV – fracture here is fully displaced, femoral head tends to lie in the neutral position in the acetabulum.[18,19]

We split the neck femoral fractures according to the AO classification system, in 31 – B1 and 31 – B2 + B3 and Garden classification in I + II and Garden III + IV, with regards to the fracture being with or without displacement.



Picture 1b. Garden's classification system of femoral neck fractures
Slika 1b. Garden klasifikacije sustava prijelom vrata bedrene kosti

Do we reduce and redesign these classification systems by increasing the inter and intra observer agreement?

It is not a rule at all that by reducing the number of possible options in which the fractures are classified we increase the amount of inter and intra observer agreement.[20] We certainly lose a certain amount of more or less important information.

The goal of this research is to answer which one of these two redesigns and reductions of the classification systems is more reliable and more reproducible in the research of inter and intra observer agreement. Secondly, there is to answer the question of whether there is a difference in the coefficients of the kappa values before and after the reshaping for each of the two observed systems. More precisely, in clinical practice, which one of the two reduced systems more reliably helps in making consolidated decisions for the methods of femoral neck fracture treatment?

Materials and methods

We randomly selected 70 anterior-posterior (AP) and lateral view preoperative radiographs of the femoral neck fractures from 423 patients who were treated for femoral neck fractures at the Trauma Department of General County Hospital, Croatia, in the past ten years, January, 2001 – January, 2011.

All radiographs that were registered in the trial were relevant in making initial decisions on treatment (operational, not operational) and in preoperative planning and choice of implants.

All marking on the radiographs (names and surnames of patients, examination dates, etc.) has been made invisible. Radiographs were marked with numbers. All fractures were classified by five observers: traumatologist, three general surgeons and an orthopedic surgeon who were very familiar with the classification systems of femoral neck fractures.

The observers classified all fractures according to AO groups and Garden.[18,19] Data were entered into pre-prepared tables specially designed for this study. The same classification procedure was repeated after three months.

Both classifications were performed independently, without mutual commenting on one's own or other's findings, and without any additional records. While classifying radiographs, observers had the option of using textbooks, atlases of trauma and the internet. All records of classification results, without any recognizable mark of authorship records except the identification number of each examiner, were stored under lock and key until the beginning of statistical analysis. Only the statistician knew the identification number of each observer.

We split AO groups for femoral neck fractures in B1 – fractures without bone displacement and B2 + B3 with displacement and the Garden I + II in fractures without bone displacement and the Garden III + IV in fractures with bone displacement.

The same procedure for classifying this kind of reduction of classification systems of femoral neck fractures was also used for the original classification systems after three months.

Inter observer agreement kappa value was calculated by comparing the first classification between observers and intra observer agreement kappa value was calculated by comparing the first and second classification for each observer.

Statistical analysis was performed by calculating the kappa values by Fleiss`s statistical methods for rates and proportion using SPSS 19 for Windows (The Statistical Package for Social Sciences – SPSS for Windows, version 19,0 SPPS inc. Chicago, ILL., USSA) statistical software for inter and intra-observer agreement.[1] Statistical significance was set at $p < 0.05$.

We interpreted the kappa value coefficient (K) according to the guidelines proposed by Landis and Koch: less than 0.00 poor reliability, 0.00 – 0.20 slight reliability, 0.21 – 0.40 far reliability, 0.41 – 0.60 moderate reliability, 0.61 – 0.80 substantial agreement and 0.81 – 1.00 almost perfect agreement.[2]

Results

Table 1 gives the results of the kappa statistical analysis of the inter and intra observer variation of the AO classification. The range of values for inter observer reliability which compared the first classifications between observers yielded coefficient kappa values (K) of from 0.32 to 0.67 with an overall mean of K = 0.48. Intra-observer analysis gave kappa values ranging from K = 0.35 to 0.67, with a mean of K = 0.55 ($p < 0.05$).

Table 2 gives the results of the kappa statistical analysis of the inter and intra observer variation of the Garden's classification. The range of values for inter observer reliability which compared the first classifications between observers yielded kappa values of from 0.33 to 0.52 with an overall mean of K = 0.42. Intra observer analysis gave kappa values ranging from 0.43 to 0.60, with a mean of K = 0.50 ($p < 0.05$).

We interpreted the kappa value coefficient according to the guidelines proposed by Landis and Koch: K = 0.41 - 0.60 moderate reliability.

The 70 fractures were then reassigned using a simplified system in without displaced (B1) and with displaced (B2, B3) for AO group and without displaced (Garden I + Garden II and with displaced (Garden III + Garden IV) to determine whether there was an improvement in the intra and inter observer agreement. The results are shown in Table 3 and Table 4.

Table 1 Kappa values of agreement for inter and intra observer agreement for the AO group classification
Tablica 1. Kapa vrijednosti kod sporazumnih pojedinačnih ispitivača i između ispitivača za AO grupu klasifikaciju

Inter observer *Između ispitivača*					Intra observer *Pojedinačni ispitivač*	
	1	2	3	4	5	X
1	X	0.64	0.42	0.55	0.67	0.67
2		X	0.32	0.40	0.46	0.70
3			X	0.42	0.47	0.35
4				X	0.46	0.64
5					X	0.37
Mean *Prosjek*	0.57	0.45	0.41	0.46	0.52	0.55

Overall mean / *Sveukupni prosjek*: 0.48 ($p < 0.05$)

Table 2. Kappa values of agreement for inter and intra observer agreement for the Garden classification
Tablica 2. Kapa vrijednosti kod sporazumnih pojedinačnih ispitivača i između ispitivača za Garden klasifikaciju

Inter observer *Između ispitivača*					Intra observer *Pojedinačni ispitivač*	
	1	2	3	4	5	X
1	X	0.52	0.45	0.36	0.33	0.69
2		X	0.46	0.37	0.40	0.43
3			X	0.41	0.44	0.52
4				X	0.40	0.45
5					X	0.43
Mean *Prosjek*	0.42	0.44	0.44	0.39	0.39	0.50

Overall mean / *Sveukupni prosjek*: 0.42 ($p < 0.05$)

Table 3. Kappa values of agreement for inter and intra observer agreement for the AO group classification reduced on without displacement and with displacement (B1 and B2+3)
Tablica 3. Kapa vrijednosti kod sporazumnih pojedinačnih ispitivača i između ispitivača za AO grupu klasifikaciju reduciranu na bez koštanog pomaka i sa koštanim pomakom

Interobserver *Između ispitivača*					Intraobserver *Pojedinačni ispitivač*	
	1	2	3	4	5	X
1	X	0.83	0.80	0.79	0.69	0.78
2		X	0.63	0.68	0.68	0.86
3			X	0.67	0.63	0.58
4				X	0.49	0.63
5					X	0.54
Mean *Prosjek*	0.78	0.70	0.68	0.67	0.63	0.68

Overall mean / *Sveukupni prosjek*: 0.69 ($p < 0.05$)

Table 4. Kappa values of agreement for inter and intra observer agreement for the Garden classification reduced on without displacement (Garden I and Garden II) and with displacement (Garden III and Garden IV)
Tablica 4. Kapa vrijednosti kod sporazumnih pojedinačnih ispitivača i između ispitivača za Garden klasifikaciju reduciranu na bez koštanog pomaka (Garden I i Garden II) te sa koštanim pomakom (Garden III i Garden IV)

Interobserver *Između ispitivača*					Intraobserver *Pojedinačni ispitivač*	
	1	2	3	4	5	X
1	X	0.88	0.79	0.47	0.71	0.88
2		X	0.40	0.51	0.56	0.95
3			X	0.49	0.41	0.60
4				X	0.75	0.70
5					X	0.59
Mean *Prosjek*	0.71	0.59	0.43	0.56	0.61	0.74

Overall mean / *Sveukupni prosjek*: 0.57 ($p < 0.05$)

The inter observer agreement was much improved. The overall mean for AO group reduced was K = 0.69, for Garden's classification reduced overall mean is K = 0.57, but the mean intra observer agreement for AO group reduced was K = 0.68 and for Garden classification reduced it was K = 0.74 ($p < 0.05$).

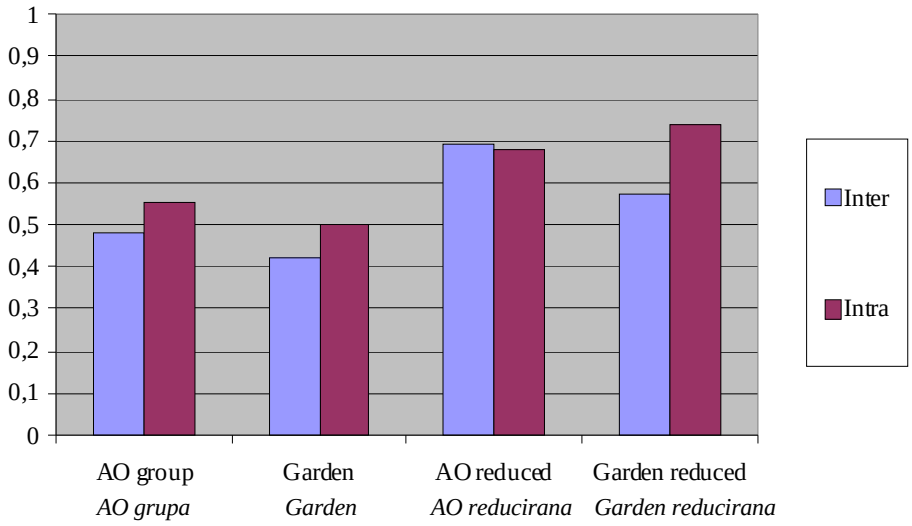
In our sample we have two observers for intra observer agreement, an almost perfect agreement (K = 0.88 and 0.95) for the reduced form of Garden's, and one in the reduced form of AO group's classification system for femoral neck fractures (K = 0.86) ($p < 0.05$).

We interpreted the kappa value coefficient (K) according to the guidelines proposed by Landis and Koch: 0.61 – 0.80 substantial agreements.

Out of possible combinations of the inter observer agreement of AO reduced to B1 and B2 + B3, only one was under K = 0.61 and that in combination with a good K = 0.49, while in the original AO group system eight were under the stated limit.

Out of ten possible inter observer combinations in the Garden classification, nine were under K = 0.61 and with the reduction there were only six possible combinations under the s et limit of K = 0.61 (substantial agreement by Landis and Koch).

Picture 2. Graphs show the results inter and intra observer agreement before and after the proposed reduction. It is visible that with the reduction of the AO group in the group without displacement (B1) and with displacement (B2 + B3) the inter observer agreement increases for the coefficient kappa value (K) for overall mean from K = 0.48 to 0.69. or 0.21 ($p < 0.05$).



Landis and Koch kappa value coeficient intepretation: less than 0.00 – poor reliability, 0.00-0.20 – slight reliability, 0.21-0.4 – far reliability, 0.41-0.6 – moderate reliability, 0.61-0.8 – substantial agreement and 0.81-1.00 – almost perfect agreement
Landis i Koch kapa vrijednost interpretacija: manje od 0,00 – slaba pouzdanost, 0,00-0,20 – lagana pouzdanost, 0,21-0,4 – daleka pouzdanost, 0,41-0,6 – umjerena pouzdanost, 0,61-0,8 – znatan sporazum te 0,81-1,00 – skoro savršen sporazum

Picture 2 Graphic inter observer overall mean and intraobserver mean for AO group, Garden, AO group reduced and Garden reduced
Slika 2. Grafički sveukupan prosjek između ispitivača i pojedinačnih ispitivača za AO grupu, Garden, AO reduciranu grupu te Garden reduciranu

The reduced form of Garden classification in without displacement (Garden I + Garden II) and fractures with displacement (Garden III + Garden IV) increases the overall mean in proportion to Garden classification from K = 0.42 to 0.57 or for 0.15 ($p < 0.05$).

Our results of the reduction on the fracture with and without displacement show an increase in intra observer mean for the AO group and for the Garden classification. For the AO group K = 0.55 on reduced form of the AO group K = 0.68 and the Garden classification with K = 0.50 on substantial agreement of K = 0.74 ($p < 0.05$).

With the reduction of Garden's classification in fractures without displacement and with displacement the intra observer agreement increases for K = 0.25, and with the reduction of the AO group in fractures with and without displacement for K = 0.13.

Discussion

The results of this research show an increase in kappa coefficient values (K) for the suggested way of reducing form of the AO and Garden's classification system.

The overall mean for inter observer agreement before reduction of the original pattern was K = 0.48 and K = 0.42 ($p < 0.05$).

The mean for intra observer agreement for A0 was K = 0.55 and for Garden K = 0.50

After the classification of the neck femoral fractures with the suggested reduction, the overall mean for inter observer agreement of AO and Garden was K = 0.69 and K = 0. 57. The mean kappa coefficient value for intra observer of AO and Garden was K = 0.68 and K = 0.74 ($p < 0.05$).

With the suggested redesign of the existing classification systems for the neck femoral fractures in the AO group and Garden, we have improved the reliability and the reproducibility.

In questioning the agreement, the reduced form of the Garden classification showed to be more reliable and reproducible than the reduced form of the AO group of vice-versa from the inter observer agreement.

We can conclude from this that the reduction of the possible number of options in which the fracture is classified according to the given classification systems increases the inter or intra observer agreement but that must not be the rule. An example is the Sidor et al result which has determined that with the decrease of the number of classification categories the modified Neer system for proximal humerus fractures has not increased the inter and intra observer agreement.[20]

With the reduction of proximal femoral fractures into groups 31 - A and 31 - B (broadly intra capsular and extra capsular), it is still not acceptable to predict the method of treatment because too much variable data is lost. For the 31 - A and 31 - B we must know if the fracture is with or without displacement.[7]

Blundell et al have determined that this division into two categories is the only classification for intra capsular fractures which has been shown to be reliable clinically and to have an acceptable degree of both inter and intra observer agreement .[8]

Other authors have based on their research of the inter and intra observer agreement for Garden's classification that this classification is only accurate for dividing fractures into those which are without displacement (Garden I + II) and with displacement (Garden III + IV).[6, 21]

Without displacement fractures customarily include those which are impacted and they may show angulation on the lateral radiographs. There may be confusion regarding the classification of intra capsular fractures which are minimally displaced and they are best considered as akin to fracture without displacement.[3]

The suggested redesign of the Garden classification system in fractures without and with dislocation (Garden I + II and Garden III + IV) in the given group of observers is not more usable and reliable and it is not a better tool in the estimation of the neck femoral fractures than the redesigned AO group. From the results, it is visible that the inter observer agreement results of the redesigned AO classification are better compared to the redesigned Garden's, while the results of intra observer agreement of the redesigned Garden's classification are better than the results of the redesigned AO. The reduced forms of the AO group and Garden's classification still are a more clinically reliable way to predict the methods of treatment of the femoral neck fractures than the Garden and AO group classification systems.

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