Influence of Modic Changes on Cervical Fusion After Single-level Anterior Cervical Discectomy and Fusion.

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Research article

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Abstract

Objective: The purpose of this study was to investigate the relationship between cervical Modic changes and cervical fusion.

Methods: This study enrolled 222 patients who underwent single-level anterior cervical discectomy and fusion(ACDF) surgical treatment between April 2014 and July 2019 at our institution, xingtai mining group general. All patients were followed up for more than 1 year after surgery. According to the presence or absence of Modic changes, 66 cases were divided into group A with Modic changes and 156 cases in group B without Modic changes. The pathological changes of cervical spine Modic were divided into 3 stages: Type 1 (inflammation or edema), manifested as endplate and subendplate The tissue is replaced by fibrovascular tissue, accompanied by granulation tissue ingrowth, bone marrow and trabecular edema; type 2 (fatty stage or yellow bone marrow stage), showing the corresponding histopathological changes as red bone marrow transition between trabecular bone It is yellow bone marrow with a large amount of adipose tissue deposition; Type 3 (osteosclerosis stage), which manifests as the endplate and the sub-endplate tissue hyperplasia and hardening into bone tissue. The bone healing process is roughly divided into the organizing period of hematoma formation; the original callus formation period; and the plastic period of callus transformation. According to Modic I, II, and III classifications, sub-groups are carried out in sequence: A1, A2, A3, and the differences in fusion between the groups during follow-up are compared.

Results: There was a statistically significant difference between the two groups at the 3 months (p=0.004) and 6 months (p=0.044) follow-up of group A and group B, and there was no statistical difference between the two groups at the last follow-up (p=0.43) Significance; the three groups of A1, A2, and A3 were followed up for 3 months (p=0.007) and 6 months (p=0.002). The difference between the three groups was statistically significant, and the difference between the three groups at the last follow-up (p=0.092) No statistical significance.

Conclusion: The fusion rate of patients with cervical Modic changes in the early and middle postoperative period is lower than that of normal cervical patients, and the fusion effect of Modic type I patients is better than that of Moidc II and III. However, the last follow-up showed that all patients have achieved fusion, that is, cervical Modic changes have a positive effect. The patient's fusion rate has no effect.

Instruction

Modic change is one of the manifestations of cervical spine degeneration. It accelerates the degeneration of cervical intervertebral discs and leads to the occurrence of cervical spondylosis. Patients often present with neck pain, which may be accompanied by stiffness of movement or even neurological symptoms to a certain extent. The imaging manifestations are the abnormal signals of the vertebral endplate and the bone under the endplate on MRI. de Roos[1] first discovered the signal change in MRI near the degeneration segment lumbar endplate in 1987. In 1988, Modic [2–3] system described the type, classification criteria and histological changes of lumbar endplate and bone MRI signal changes under the endplate and called it Modic change.See Figue 1. In recent years, literature studies have shown that [4–5] Lumbar Modic changes have a certain effect on fusion. In the lumbar spine, Kwon et al. [6] reported that patients with MCs fused after posterior lumbar interbody fusion (PLIF) The rate is lower than that of patients without MCs. Modic changes of the cervical spine are similar to that of the lumbar spine [7–8]. However, as far as we know, there are few reports about the impact of cervical Modic changes on anterior cervical fusion, especially the early postoperative fusion rate. This article aims to Explore the relationship between cervical Modic changes and cervical fusion, and provide objective guidance for clinical treatment.

Materials And Methods

Patients

For this study, we enrolled 241 patients with or without MCs who underwent single-level ACDF between April 2015 to July 2019 at our institution. Among them,66 cases of diseased segments with Modic changes are group A, of which 27 cases of Modic type I are group A1, 30 cases of Modic type II are group A2, and 9 cases of Modic type III are group A3, as shown in Fig. 1, without Modic The 156 changed cases were group B, with 103 males and 138 females, aged 41–69 years, with an average of 51.7 years, regular follow-up 3 months, 6 months, 1 year after operation .They were divided into two groups according to modic changes, respectively. Studies were included if they met the following inclusion criteria: (1) Cervical spondylotic myelopathy with Modic changes in the endplate of the diseased segment, with obvious neurological symptoms, patients who underwent single-segment ACDF surgery without conservative treatment for 3 months.(2)Imaging data were available and complete at 3 months, 6 months, and 1 year after surgery. Exclusion criteria :(1)patients with multi-stage cervical spondylotic myelopathy infectious diseases (2)history of cervical spine trauma, tumor, surgery.(3)Patients with congenital cervical deformity.(4)People with infection after surgery.

This study was approved by the Orthopedics Hospital of Xingtai City Ethics Committee. Written informed consent was obtained from each patient, and all clinical procedures were carried out according to the principles in the Declaration of Helsinki.

Surgical methods

In our study, all operations were conducted by one neurosurgeon. The patient is placed in the supine position.After administration of general anesthesia, the right-side Smith-Robertson approach was performed through a transverse incision, about 5cm in length, and the skin, subcutaneous, and platysma are cut in sequence, and entered between the carotid sheath, trachea, and esophagus. Before the vertebral body, fluoroscopy determines the vertebral body, installs the Caspar spreader we carefully confirmed the surgical level was by intraoperative radiography. Then, the intervertebral space was distracted using a Caspar vertebral body distractor, adjusts the proper spreading distance, removes the intervertebral disc with the nucleus pulposus forceps, cuts the posterior longitudinal ligament, uses the bone forceps to bite off the posterior osteophytes, and implants suitable autogenous bone The cage(Manufacturer: Zimmer Spine) is fixed with steel plate and screws, washed with saline, indwelling the drainage strip, suture the wound layer by layer, and dress the wound. Postoperatively, the patients got out of bed one day after the operation; the patients were requried to wear a neck brace for12 weeks when sitting or wailing and quit smoking.

Observation index

Routine follow-up at 3 months, 6 months and 1 year after operation, according to follow-up imaging evaluation fusion, this experiment used Toth et al. [9] fusion evaluation method: grade 0, no new bone formation, no fusion; grade 1, new bone exists and attempts to bridge from only one side; grade 2, new bone When bridging is "attempted" from both sides; level 3, the new bone tries to fuse from the head and tail of the vertebrae, but does not extend beyond the anterior edge of the vertebral body; level 4, the new bone fusion block extends to the front edge of the adjacent vertebra See Fig. 2.

Statistical analysis

IBM SPSS Statistics 21 (SPSS Inc., Chicago, IL, USA) was used for data analysis. The measurement data adopts the mean ± standard deviation, and count data were presented as frequencies and percentages, analyzed by the Chi-square test or Kruskal-Wallis test. independent samples were analyzed by T-tests.P-values < 0.05 were considered statistically significant.

Results

There was no statistically significant difference between the two groups of patients in gender, age, BMI, intraoperative bleeding, operation time, and operation segment ($P > 0.05$), see Table 1.

The follow-up found that the fusion of group A and group B was statistically significant between the two groups at the 3-month ($p = 0.004$) and 6-month ($p = 0.044$) follow-up. The last follow-up ($p = 0.43$) between the two groups The difference was not statistically significant, see Table 2.

In group A, the three subgroups of patients in 3 months, 6 months, and 1 year changed their fusion status, and there were statistically significant differences between the 3 months ($p = 0.023$) and 6 months ($p = 0.042$). The 1-year follow-up ($p = 0.096$) showed no significant difference between the three groups, as shown in Table 3. Further analysis found that Modic I, II, III followed up for 3 months and 6 months to change the percentages of grade 3 and 4 fusion A1 > A3, A1 > A3, indicating that Modic I fusion effect is better than Modic II and III in the early and mid postoperative period.

Discussion

In our study we found that the postoperative fusion rate of patients with cervical Modic changes is lower than that of normal cervical patients.

Stress theory and integration

Anterior cervical discectomy and fusion (ACDF) is considered the gold standard for the treatment of degenerative cervical disease. Intervertebral fusion is one of the most important indicators to evaluate the success of ACDF [10–11]. For example see figue 3.Firm bone fusion is the key to the best long-term prognosis. MCs are considered to be part of the changes in inflammation, edema and congestion. Modic et al. believe that [1–2] Type 1 changes indicate the inflammatory phase of the degenerative process; Type 2 changes represent fatty degeneration of subchondral bone and bone marrow; Type 3 changes indicate the healing stage of intervertebral disc degeneration.According to the biomechanical hypothesis, with age, the intervertebral disc degeneration will become heavier and heavier, the cartilage endplate is gradually replaced by the bony endplate, the loss of the interdiscal space and the degeneration of the facet joints change the biomechanics, Leading to microfracture of the endplate[12].Bendix et al. [13] proved that patients with a lot of labor are more likely to have microfractures of the endplate, resulting in Modic changes.The histological characteristics of type 1 MCs are the thickened trabecular bone of the endplate and granulation tissue and fibrous tissue that infiltrate and destroy blood vessels, while the destruction of type 2 MCs endplate is caused by chronic repetitive hematopoietic tissue damage and replacement of bone marrow and fat. organization. The histological feature of type 2 MCs is the formation of bone sclerosis, confirming the above hypothesis. According to Woff's theory, tensile stress can promote bone fusion, while tensile stress inhibits bone fusion. Modic changes in patients with increased pressure load, which inhibits the formation of new bone[14].These articles just confirmed this point of view.In this study, the percentage of cervical spine 3 and 4 fusions in the patients without cervical Modic change was greater than that of the Modic change group, as shown in Fig. 4. That is, the fusion effect of the cervical spine without Modic change group was better than that of the cervical spine modic group. Change has changed.

Changes in the microenvironment and fusion

Studies have shown that for patients with MCs, the local microenvironment at the surgical level may affect fusion [15–17]. Toyone et al. [18] found that Modic type 1 patients had poorer stability than those without Modic changes. Another study found that the endplate damage caused by Modic3 inhibits the nutrition and blood supply of the bone graft area, which may also affect fusion [19]. Changes in the microenvironment will affect the nutrient supply of the endplate, leading to the delay of endplate repair. A large number of active osteoclasts and osteoblasts will cause increased woven bone, thickening of trabecular bone and microstructure changes, which will affect fusion. Other studies have shown that the endplate is milky white in the fresh state, and its tissue contains a variety of biological factors including tumor necrosis factor (TNF) and protein gene products (PGP), as well as biological factors such as interleukins produced by immunogenic activation 6, 8 and prostaglandin E2 have been confirmed to be related to Modic changes. In this study, Modic changed the percentage of grade 3 and 4 fusion in type I cases than Modic II and III, as shown in Fig. 5.The author believes that the hematoma formation period is equivalent to the Modic altered inflammation period, in which a large number of osteoblasts are formed, and the growth of new capillaries is a key factor in the occurrence of new bone[20].While the original callus formation period and the plastic period of callus transformation are equivalent to the steatosis period and the bone sclerosis period, a large amount of fat deposits and red bone marrow turn into yellow bone marrow, resulting in slower healing after fusion.The conclusion of this study that the fusion rate of patients with cervical Modic changes in the early and middle postoperative period is lower than that of normal cervical patients. However, the influence of cervical Modic changes on the effect of intervertebral fusion is still controversial, and the specific relationship needs further research.

Of course, there are many factors that affect fusion, in addition to the above reasons, such as age, cartilage endplate treatment, follow-up time, etc. Choi et al. [21] found the extensor CSAs were related to fusion rate and timing. In particular, as the extensor CSAs increased, fusion timing decreased.Ren Ba et al.[22] Through univariate and multivariate analysis, the most important finding of this study is that the slopes of C2-C7, C2-C7 ROM, C2-C7 SVA and T1 are positively correlated with cage nonunion after ACDF.Kim [23] reported that the high slope of T1 is a predictive risk factor for kyphosis caused by poor fusion.These will affect the fusion of the cervical spine.

In this study, cervical Modic changes did not affect the final fusion, but delayed healing occurred during follow-up. For delayed healing cases, delayed fusion patients may have more implant complications, such as broken screws and screws Fractures and false joints, in order to avoid loosening and non-fusion of internal fixation, patients are required to reduce neck activities and extend the wearing time of neck brace. Cause patients to complain about the inconvenience of life. Delayed healing may be related to Modic changes, the specific mechanism is not clear.

This article has certain limitations. Some unknown factors may affect the relationship between Modic changes and fusion of the cervical spine, such as the amount of bone graft, the parameters of the cervical spine sagittal plane, the degree of cartilage endplate and residual soft tissue processing. There are few studies on cervical Modic changes and fusion in the literature, and there are not many references. In addition, the sample size of this study is relatively small, and it is necessary to collect more cytological and molecular data on cervical Modic changes and fusion in a large-sample multi-center study to further prove.

Conclusions

The fusion rate of patients with cervical Modic changes in the early and mid-term postoperatively was lower than that of normal cervical patients, and the fusion effect of Modic I patients was better than that of Moidc II and III. The fusion rate has no effect.

Abbreviations

BMI: body mass index, ACDF: anterior cervical decompression and bone grafting fusion, MCs: Modic changes, TNF: tumor necrosis factor, PGP: protein gene products .

Declarations

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Ethics approval and consent to participate

This study was approved by the Institutional Ethics Board of the The Orthopedics Hospital of XingTai City and informed consent was obtained from all individual participants included in the study.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1

Basic information of patients

	A group	B group	P
gender (M/F)	32/34	78/77	0.80
age (years)	50.1 ± 3.7	52 ± 3.1	0.54
BMI	26.3 ± 1.8	27.2 ± 3.1	0.49
Intraoperative blood loss(ml)	101.9 ± 4.5	98.7 ± 3.2	0.74
Length of operation(min)	60.5 ± 1.4	61.3 ± 2.4	0.43
Surgical segment C4-5/C6-5/C6-7	22/19/25	53/49/54	0.88

Table 2

Distribution of fusion levels of group A and group B

Fusion level															
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
	3months					6months					1year				
A group	4	17	15	19	11	2	14	12	24	14	0	0	0	30	36
B group	7	12	33	60	44	5	11	31	62	47	0	0	0	62	94
p	0.004					0.044					0.43				

Table 3

Modic change classification and fusion level distribution

Fusion level															
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
	3months					6months					1year				
Modic I	0	3	5	13	6	0	2	4	14	7	0	0	0	9	18
	0.0%	11.0%	18.5%	48.1%	22.2%	0.0%	7.7%	15.4%	50.0%	26.9%	0.0%	0.0%	0.0%	33.3%	66.7%
Modic II	2	12	7	5	4	1	12	6	5	6	0	0	0	18	12
	6.7%	40.0%	23.3%	16.7%	13.3%	3.3%	40.0%	20.0%	16.7%	20.0%	0.0%	0.0%	0.0%	60.0%	40.0%
Modic III	2	2	3	1	1	1	1	1	4	2	0	0	0	3	6
	6.1%	25.8%	22.7%	28.8%	16.7%	3.3%	24.6%	18.0%	31.1%	23.0%	0.0%	0.0%	0.0%	45.5%	54.5%
p	0.023					0.042					0.096				

Figures

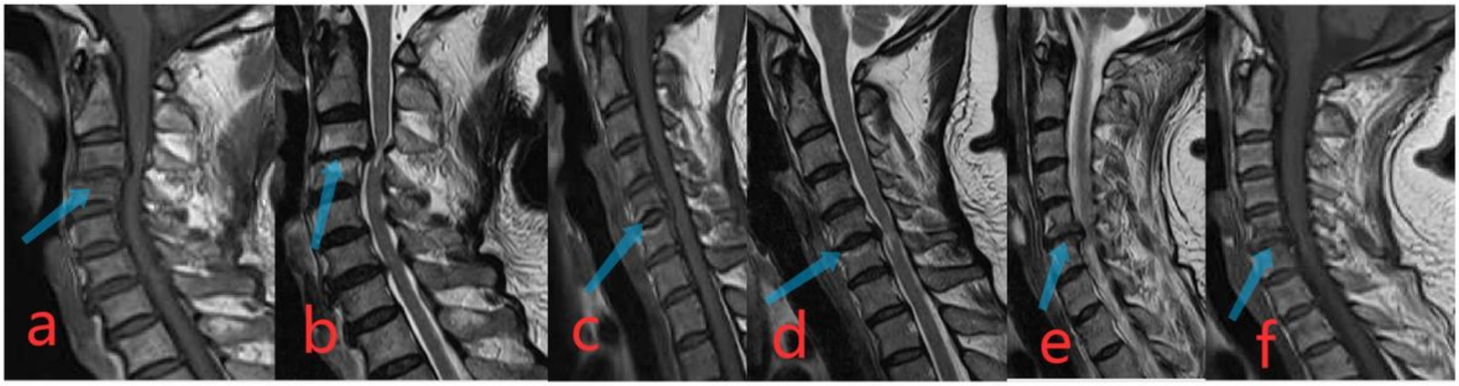

Figure 1

Modic type a C3/4 unstable T1WI, lower signal at the upper and lower edges of C4 vertebral body (shown by arrow) b T2WI, higher signal at upper and lower edge of C4 vertebral body (shown by arrow) Fig. 2 Modic Type, C5/6 c T1WI, C6 high signal at the upper and lower edges of the vertebral body (indicated by the arrow) d T2WI, C6 high signal at the upper and lower edge of the vertebral body (indicated by the arrow) Figure 3 Modic type , C5/6 unstable e T1WI, low signal on the upper and lower edges of C6 (shown by the arrow) f T2WI, low signal on the upper and lower edges of the LC6 (shown by the arrow)

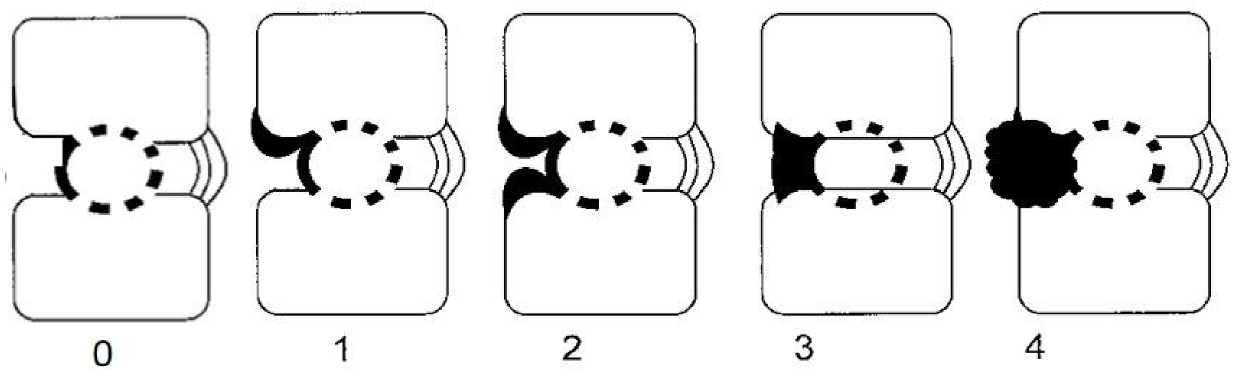

Figure 2

fusion evaluation method

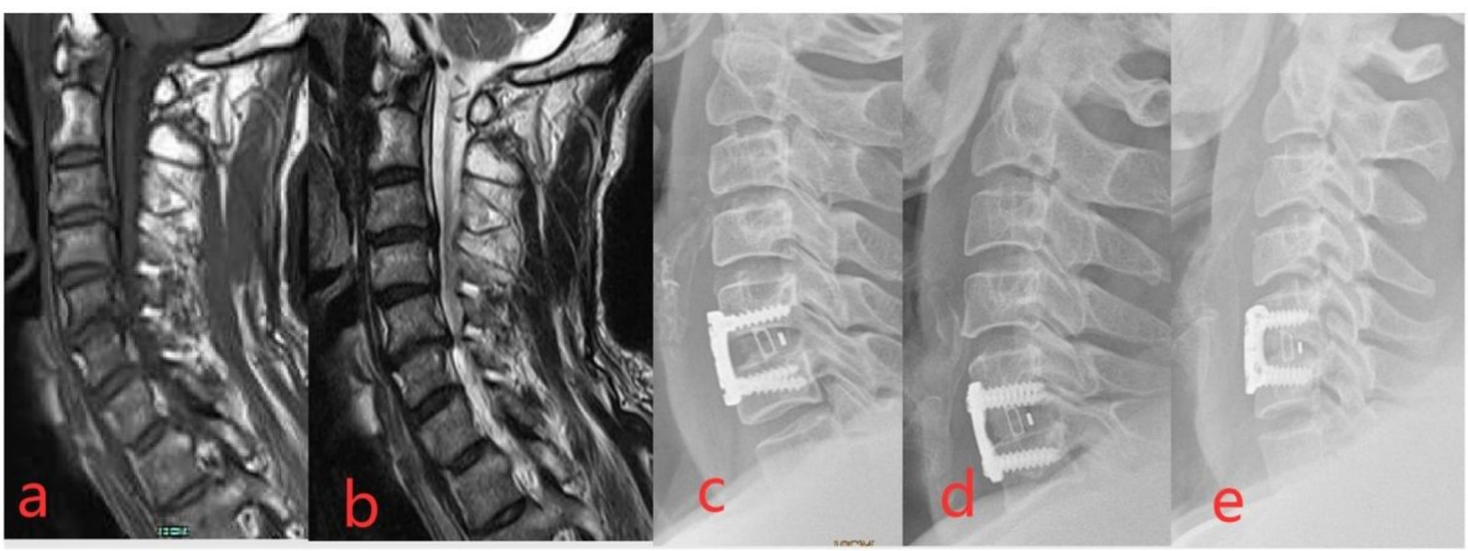

Figure 3

Example of a 55-year-old woman with Modic III (a, b) who underwent ACDF. The profile imaging examination showed that during the fusion process during the routine follow-up (c, d, e), bone fusion was achieved in the final follow-up.

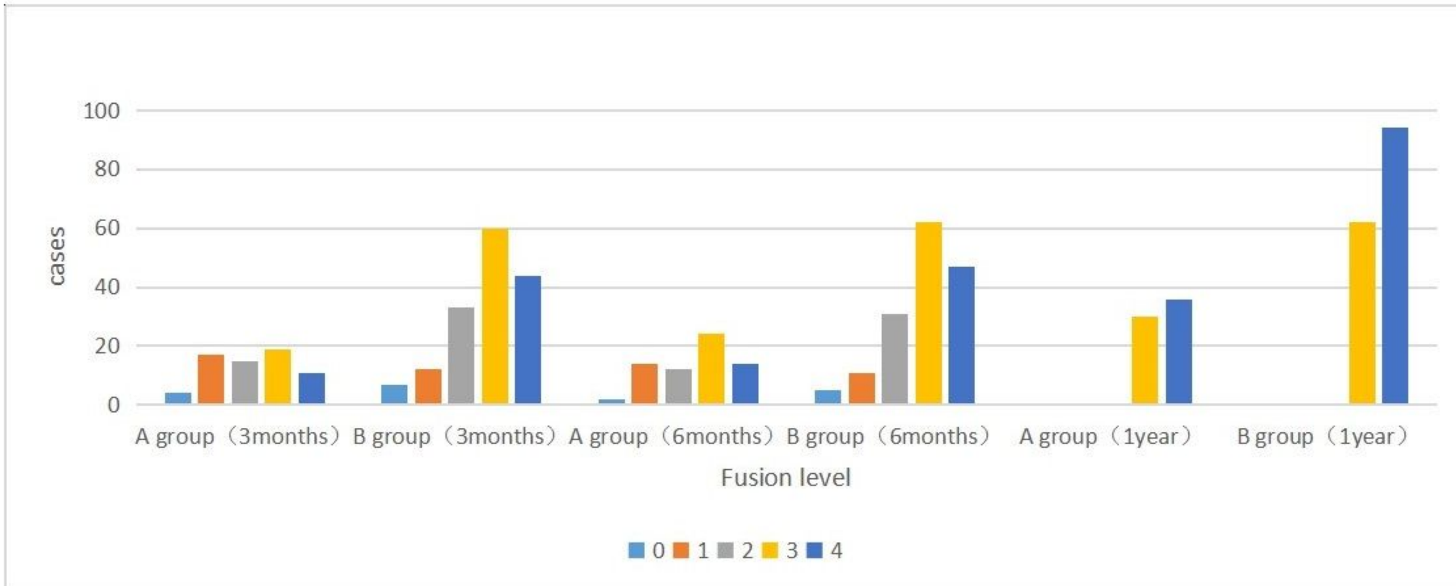

Figure 4

Distribution of fusion grades in groups A and B

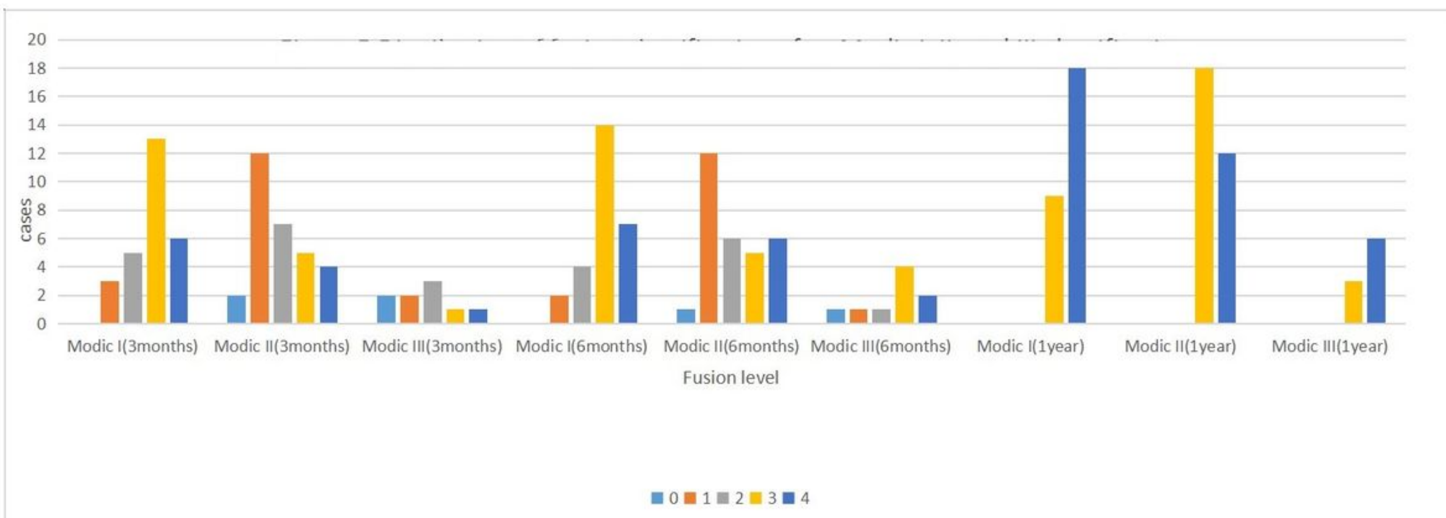

Figure 5

Distribution of fusion classification after Modic I,II and III classification