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TIME FROM INJURY TO SURGERY IMPACT ON RECOVERY RESULTS AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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Key words: anterior cruciate ligament reconstruction; time to surgery; GNRB®; residual laxity.

Summary

Purpose: the aim of this study is to determine do the time factor have influence on recovery results after ACL-R in line with other patient related factors.

There are hypotheses as follow:

1. Early ACL-R have lower the postoperative laxity difference measured.
2. Incidence of meniscal tears and chondral degenerative changes increase in late ACL-R.

Material and methods. 207 consecutive patients were analysed, who underwent reconstruction of anterior cruciate ligament between January 2014 and January 2016. Patients were divided into three groups according to the time from injury to surgery (≤3 months, 3.1 - 12 months, and > 12 months to surgery). ACL-R surgery using a quadrupled hamstring strand, single-bundle autograft was performed for all patients. Follow-up examinations were performed at 3, 6 and 12 months postoperatively. At all follow-up visits laximetric measurement were performed using GNRB® (GeNouRoB, France). A "residual laxity" of the ACL-R was defined by a differential laximetric of greater than 3 mm at 134 N (Δ134 > 3 mm).

Results. 207 patient evaluated, there were 53 (25.6%) men and 154 (74.4%) women with the mean age 33.21 ± 9.78 years (range 18 - 55), and median is 33 years. The mean time from injury to surgery was 17.66 (35.66) months, median 4.5 months. There was a significant difference in the incidence of meniscal tears between patients treated in the early group (13 (18.3%)) and in those underwent ACL-R after 12 months (25 (46.3%)), ($P < 0.001$). The examination of possible risk factors for medial meniscus tear revealed, that BMI (overweight) (OR=2.04; 95% CI=1.091-3.814) and time from injury to surgery (weeks) (OR=1.026; 95% CI=1.012-1.04) significantly increased possibility of medial meniscus tear. We found no significant laxity difference between postoperative testings' (3, 6 and 12 months after surgery) and the three groups, created by the time to surgery.

Conclusion. The study revealed a significant difference in the incidence of meniscal tears between patients treated in the early group and in those underwent ACL-R after 12 months, which lead to significantly higher chance (every delayed week increase chance by 1.026 times and overweight (BMI ≥ 25 kg/m^2) increase chance by 2.04 times) of a medial meniscal tear occurring in patients undergoing delayed reconstruction.

Introduction

Active way of life is highly prioritized in our days and more people are involved in sport activities. Contact sports such as football, basketball, skiing are determined as high-risk sports and ACL injuries in these sports are more common (1). Motions that occur with cutting and pivoting, such as varus/ valgus and internal/external rotation movements at the knee, can result in rupture of the ACL (2). Conservative treatment of ACL rupture is one of the possibilities and sometimes successful, but patients, willing to return to sports and high level activities are not satisfied with conservative treatment outcomes (3). To achieve best results - ACL reconstruction (ACL-R) is needed to perform. There are variety of surgical methods to achieve good post-operation

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results, but in literature is still debate of optimal timing to perform reconstructive surgery. For athletes it is important to return to previously achieved level of sport as soon as possible, but ordinary people, not involved in physically demanding activities, this timing isn't so ticking.

The incidence of meniscal tears is increased in the anterior cruciate ligament deficient knee and there is some evidence to indicate that degenerative changes develop with time(4). Millett et al study showed that delayed reconstruction in the young was associated with a higher incidence of medial meniscal tears (5). However, there are no clear guidelines regarding the timing of reconstruction in regard to reducing the rate of meniscal pathology and achieve best outcomes.

The aim of this study is to determine do the time factor have influence on recovery results after ACL-R in line with other patient related factors.

There are hypotheses as follow:

1. Early ACL-R have lower the postoperative laxity difference measured.
2. Incidence of meniscal tears and chondral degenerative changes increase in late ACL-R.

Material and methods

Two hundred and seven consecutive patients were reviewed, who underwent reconstruction of anterior cruciate ligament between January 2014 and January 2016. The inclusion and exclusion criteria are given in Table 1. Patients were divided into three groups according to the time from injury to surgery (≤3 months, 3.1 - 12 months, and > 12 months to surgery). The operative patient age, gender, injured side, time from injury to surgery, concomitant injuries, height and weight were recorded before surgery. The graft diameter, meniscal tears and degeneration of articular surface were recorded at time of surgery. The incidence of degenerative articular surface change found at surgery was classified using the French Society of Arthroscopy (SFA) system (6). Standard radiographs and MRI were obtained for all patients to rule out any additional bony injuries and to evaluate ligamentous, cartilaginous and meniscal injuries (Table 1).

Surgical technique. An anatomical single-bundle ACL-R with autologous hamstring tendon grafts (minimum graft diameter in this study was 7.0 mm) was performed for every patient in this study. The femoral bone tunnel was carried out through a very low anteromedial portal in maximum knee flexion and was placed in the centre of the native ACL footprint. For tibial bone tunnel placement, the arthroscopic aimer was inserted to the knee through the anteromedial portal and was adjusted to 45° when drilling and was positioned approximately 5 mm behind the anterior meniscal ligament in a middle distance between the anterior horn of lateral meniscus and medial eminence of tibia. After guide pin is drilled, the drill guide is removed and the knee is passively extended to exclude an impingement on the anterior intercondylar notch and medial wall of lateral femoral condyle. Once a check is performed, tibia tunnel is established with a cannulated reamer to the graft diameters. The reaming debris is evacuated with a synovial shaver to minimize the fat pad inflammatory response. After tunnel on both femoral and tibia side creation, grafts were inserted and then fixed with bio absorbable interference screws proximally and distally. The knee was cycled several times through the range of motion and the graft was examined arthroscopically to check tension and fixation quality and to exclude graft impingement.

Table 1. Inclusion criteria

Inclusion criteria	Exclusion criteria
Complete ACL tear	Partial ACL tear
Age 18 to 55 years	Bilateral ACL ruptures
	Combined ligament injuries
	Injury of the posterior cruciate ligament
	Concomitant fractures

Table 2. Patient and laxity's characteristics
Values are expressed as mean ± standard deviation

	≤ 3 months	3.1 -12 months	> 12 months	P
Number of cases in groups	71 (34.3 %)	82 (39.6%)	54 (26.1%)	0.056
Age at surgery (years)	32.44 ± 8.70	32.79 ± 10.73	34.69 ± 9.88	0.409
Gender (women/men)	22/49	18/64	13/41	0.446
Height (cm)	180 ± 10.79	180 ± 9.3	178 ± 8.36	0.439
Weight (kg)	82.72 ± 16.66	84.23 ± 13.92	82.52 ± 14.37	0.754
BMI (kg/m^2)	25.47 ± 3.83	25.95 ± 3.69	25.97 ± 3.74	0.668
Δ134N pre-op (mm)	3.69 ± 1.36	4.09 ± 1.38	4.26 ± 1.44	0.061
Δ134N after 3 months (mm)	1.16 ± 0.90	1.24 ± 1.06	1.37 ± 1.18	0.678
Δ134N after 6 months (mm)	1.17 ± 1.21	1.13 ± 0.81	1.38 ± 1.12	0.420
Δ134N after 12 months (mm)	1.06 ± 1.02	1.25 ± 1.15	1.46 ± 1.14	0.098
No. of residual (%) laxity > 3 mm	3 (4.8 %)	7 (10.8 %)	3 (5.7%)	0.446

Rehabilitation. All patients underwent a standardized rehabilitation protocol. An extension knee braces were used for two weeks and protected weight bearing was allowed for 2 weeks as tolerated. On the second postoperative week, the brace was fixed to allow motion between 0° and 60° of flexion, quadriceps activity against gravity and hamstring contractions were permitted. Four weeks after surgery, patients were allowed knee motions between 0° and 90° of flexion, and quadriceps exercises were allowed between 45° and 90° of flexion. At 6-8 weeks full isotonic hamstring contraction, hip abductor-adductor exercises, and swimming were permitted. At eight weeks, patients were encouraged to achieve a full range of motion, to extend the knee against unlimited resistance between 45° and 90° of flexion, and to ride a stationary bicycle with resistance. At twelve weeks, unrestricted isotonic quadriceps-strengthening was allowed between 0° and 90° of flexion. Return to sports activity was allowed gradually 8 to 12 months postoperatively, and after one year without any restrictions.

Patient evaluation. Follow-up examinations were performed at 3, 6 and 12 months postoperatively by one orthopaedic surgeons. At all follow-up visits laximetric measurement were performed using GNRB® (GeNouRoB, France). The measurement accuracy of the GNRB® is 0.1 mm (7). A "residual laxity" of the ACL-R was defined as a differential laximetry greater than 3 mm at 134 N (Δ134 > 3 mm).

Statistical analysis

For statistical analysis, IBM SPSS® 24.0 was used. Patients were divided into three groups according to the time from injury to surgery (≤3 months, 3.1 - 12 months, and > 12 months to surgery). The normal distribution was tested and confirmed with the Kolmogorov-Smirnov test for the metrical data. Descriptive characteristics are presented as mean ± standard deviation and range. The analysis of variance (ANOVA) method was used for the analysis of variables that met the assumptions of the application. General Linear Model (Repeated Measures) was used to evaluate follow-up examinations, which were performed at preoperatively, 3, 6 and 12 months postoperatively. These four points in time measures (before surgery, 3, 6 and 12 months postoperatively) for differential laximetry at 134N (Δ134 = healthy side vs operated side) were used as time factor (within-subject factor) and analysed by investigation groups. Bonferroni pair-wise multiple comparisons test was used for post hoc pair-wise comparisons. Kruskal-Wallis (One-way ANOVA on ranks) test was used to determine statistically significant differences between more than two groups of an independent not normally distributed variable. To evaluate differences between categorical factors the Pearson Chi-squared test and Fisher's exact test were used. Logistic regression model for potential risk factors of the medial meniscus tear prediction was made. All statistical tests were computed considering a threshold of 0.05 as statistically significant.

Results

207 patient evaluated, there were 53 (25.6%) men and 154 (74.4%) women with the mean age 33.21 ± 9.78 years (range 18 - 55), and median is 33 years. The demographic data of the study across the groups are shown in Table 2.

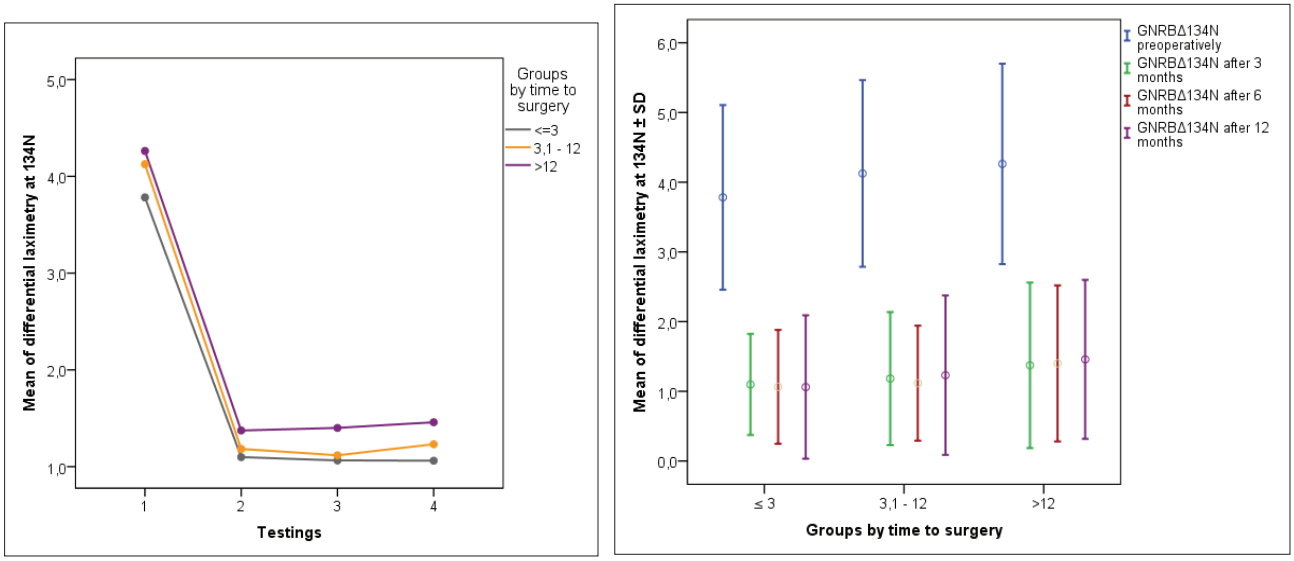

Figure 1. Laximetric GNRB® data according to time to surgery in 4 testings'.

Laximetric GNRB® data according time from injury to surgery. The mean time from injury to surgery was 17.66 (35.66) months, median 4.5 months. We analysed patients, divided into groups (up to 3 months to surgery, 3.1 to 12 months to surgery and more than 12 months to surgery). The mean GNRB® Δ134N laximetric difference (Figure 1) in ≤ 3 months to surgery group was 1.16 ± 0.9mm, 1.17 ± 1.21mm, 1.06 ± 1.02mm for postoperative testing in 3, 6 and 12 months after surgery, respectively. The mean GNRB® Δ134N laximetry difference in 3.1 - 12 months group was 1.24 ± 1.06 mm, 1.13 ± 0.81 mm, 1.25 ± 1.15 mm for postoperative testing in 3, 6 and 12 months after surgery, respectively. The mean GNRB® Δ134N laximetry difference in >12 months to surgery group was 1.34 ± 1.18mm, 1.38 ± 1.12mm, 1.46 ± 1.14 mm for postoperative testing in 3, 6 and 12 months after surgery, respectively. We found no significant laxity difference between postoperative testings' (3, 6 and 12 months after surgery) and the three groups, created by the time to surgery.

Residual laxity. There were 13 (6%) patients with "residual laxity" in our study. Distributions in time to surgery groups is shown in Table 2. The highest incidence is registered in 3.1 to 12 months group, but difference between groups is not statistically significant.

Analysing body mass index criteria, there were 120 (56%) overweight patients in our study (BMI ≥25 kg/m^2) and 25 (11.7%) of those BMI was higher than 30 kg/m^2. There were 4 (5.3%) cases of "residual laxity" in group of BMI < 25 kg/m^2, and 9 (8.4%) in group of BMI ≥25 kg/m^2.

Table 3. Incidence of degenerative changes in groups

	Time to surgery (months)		
Degenerative changes by SFA	**T1 (≤ 3 month)**	**T2 (3 to 12 months)**	**T3 (>12 months)**
0	54 (76.1%)	62 (75.6%)	36 (66.7%)
I	0	0	1 (1.9%)
II	6 (8.5%)	6 (7.3%)	6 (11.1%)
III	7 (9.9%)	8 (9.8%)	6 (11.1%)
IV	4 (5.6%)	6 (7.3%)	5 (9.3%)

Table 4. Logistic regression model results

	B	S.E.	Wald	df	*P*	Exp (B)	95% C.I. for EXP(B)	
							Lower	Upper
Time (weeks)	,026	,007	13,239	1	,000	1,026	1,012	1,040
(BMI ≥ 25 kg/m^2)	,713	,319	4,982	1	,026	2,040	1,091	3,814
Constant	-,919	,287	10,225	1	,001	,399		

Incidence of meniscal tears in time to surgery groups. Our study revealed, that there were 13 (18.3%) medial meniscus tears in early group (up to 3 months to surgery), compared with 31 (37.8%) in late (3.1 to 12 months to surgery) group, and 25 (46.3%) in delayed (more than 12 months to surgery) group. There was a significant difference in the incidence of meniscal tears between patients treated in the early group and in those underwent ACL-R after 12 months ($P < 0.001$). The incidence of lateral meniscus tears was 18 (25.4%) in the early group compared with 8 (9.8%) in late group, and 2 (3.7%) in the delayed group. There was statistically significant difference in the incidence of lateral meniscus as well ($P < 0.001$). The incidence of both meniscus tears was pretty similar in all groups - 14 (19.7%) in the early group, 15 (18.3%) in late group, and 17 (31.5%) in the delayed group, but no significant difference was found.

Logistic regression model for potential risk factors of the medial meniscus tear prediction was made. The logistic regression model was suitable, likelihood ratio criterion $\chi^2 = 15.612$; $P < 0.001$. Gender and age were eliminated as statistically insignificant predictors. The examination of possible risk factors for medial meniscus tear revealed (Table 4), that BMI (overweight) (OR=2.04; 95% CI=1.091-3.814) and time from injury to surgery (weeks) (OR=1.026; 95% CI=1.012-1.04) significantly increased possibility of medial meniscus tear. Correctly classified 76.5% sample subjects.

Incidence of degenerative change of joint cartilage in groups. The incidence of degenerative change of joint cartilage found at surgery was compared to the early, late and delayed groups, classified using the French Society of Arthroscopy (SFA) system (Table 3).

The incidence of grades 1, 2, 3 and 4 of degenerative change was higher in the delayed group compared with the early group, but difference was not significant.

Discussion

We failed to find evidence to suggest that an early reconstruction is of benefit to sports-active individuals with a rupture of the ACL in correlation with graft diameter. Our median time to surgery was 4.5 months (or 18 weeks), but we found no statistically significant difference in postoperative differential laxity (3, 6 and 12 months after surgery) between three graft diameter groups, although differential laxity in large diameter group was higher than in small group (1.37 vs 1.03 mm). There is also lack of comparative literature data to compare laximetry data. Karlsson et al (8) found that reconstruction, performed between two and 12 weeks after injury

resulted in a higher activity level for competitive athletes. There was also a decrease in meniscal damage when compared with delayed surgery. Meighan et al (9) conclude that there is no advantage in early reconstruction for isolated tears of the ACL and that this is associated with an increased rate of complications. Delayed surgery is associated with a more rapid return of movement and muscle function. In addition, a delay in surgical intervention allows the surgeon time to assess more carefully a patient's suitability for reconstruction of the ACL.

In line with Church et al (10), our study revealed, that there was a significant difference in the incidence of meniscal tears between patients treated in the early group and in those underwent ACL-R after 12 months. The incidence of lateral meniscus tears was 18 (25.4%) in the early group compared with 8 (9.8%) in late group, and 2 (3.7%) in the delayed group. This may indicate that lateral meniscal tears occur at the time of injury or very soon after, whereas medial meniscal tears are acquired after the knee has been ACL-deficient for longer period of life. Our results support the idea of a significant increase in MM tears after 12 months from injury (10–12). Granan et al. (13) found that each month of delayed ACL-R results in an increased odds ratio of further cartilage and meniscal damage of 1. Brambilla et al. (11) demonstrate that a delay of ACL-R is associated with a 0.6 % higher risk per month for further joint injury (our study demonstrates only 0.104% per month). Additional to the risk of further damages to the knee, it is obvious that especially athletes try to avoid an unnecessary delay regarding return to sports due to a delayed ACL surgery. Brambilla et al. (11) also revealed, that prevalence of cartilage injuries increased significantly at 12 months in the medial compartment, but later in the lateral one, with a statistical significance only for subjects treated after 60 months. We failed to find statistically significant difference, but study can indicate, that cartilage lesions (grade 2 to 4) incidence was higher in late group (over the 12 months) (24% vs 31.5%).

We also found, that BMI (overweight (BMI $\geq$ 25 kg/m^2)) odds ratio estimate of 2.04 and the time from injury to surgery (weeks) estimate the odds ratio 1.026, which shows, that BMI and time to surgery are strong risk factors to gain meniscus rupture until delayed surgery. The correlation between BMI and the prevalence of associated lesions suggests that joints of overweight people are subjected to greater mechanical loads, as suggested by the higher incidence of arthrosis (14). So this supports idea of earlier ACL-R in this subgroup of patients.

Conclusion

The study revealed a significant difference in the incidence of meniscal tears between patients treated in the early group and in those underwent ACL-R after 12 months, which lead to significantly higher chance (every delayed week increase chance by 1.026 times and overweight (BMI $\geq$ 25 kg/m^2) increase chance by 2.04 times) of a medial meniscal tear occurring in patients undergoing delayed reconstruction. According to this, we recommend that ACL reconstruction not be delayed more than a year after the injury, due to the increased risk of meniscal tears and chondral injuries after this period. The correlation between BMI and associated lesions suggests that surgeons take into account the possibility of an earlier ACL reconstruction in overweight patients.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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LAIKOTARPIO TRAUMA-OPERACIJA ĮTAKA POOPERACINIAMS KELIO SĄNARIO REZULTATAMS PO ATLIKTOS PRIEKINIO KRYŽMINIO RAIŠČIO REKONSTRUKCIJOS

R. Jurkonis, R. Gudas

Raktažodžiai: priekinio kryžminio raiščio rekonstrukcija, laikotarpis iki operacijos, GNRB®, išliekantis sąnario laisvumas.

Santrauka

Tikslas: įvertinti, ar laikotarpio (nuo traumos iki operacijos) faktorius turi įtakos pooperaciniams kelio sąnario rezultatams po atliktos priekinio kryžminio raiščio rekonstrukcijos (PKRR) kartu vertinant ir kitus, antropometrinius duomenis.

Tikslui pasiekti išsikėlėme šias hipotezes:

1. Esant trumpesniam laikotarpiui nuo PKR traumos iki operacijos, stebimas mažesnis PKR tamprumo skirtumas tarp abiejų kojų;
2. Ilgėjant laikotarpiui nuo traumos iki PKRR, didėja meniskų plyšimų ir sąnarinės kremzlės pažaidos galimybė.

Metodai: tyrime dalyvavo 207 pacientai, kuriems 2014 – 2016 metais buvo atlikta PKRR. Pacientai buvos suskirstyti į tris grupes pagal laikotarpį nuo įvykusios traumos iki operacijos (≤3 mėnesiai, 3,1 - 12 mėnesių, ir > 12 mėnesių iki operacijos). Visiems pacientams PKRR atlikta panaudojus keturis kartus sulankstytą lenkiamųjų sausgyslių transplantą. Tiriamųjų testavimai buvo vykdomi praėjus 3, 6 ir 12 mėnesių po operacijos, kurių metu buvo matuojamas PKR tamprumo skirtumas tarp abiejų kojų, panaudojant GNRB® (GeNouRoB, Prancūzija) aparatą. „Išliekantis laisvumas“ buvo charakterizuotas tuomet, kai tamprumo skirtumas (tarp abiejų kojų) buvo didesnis nei 3 mm matuojant 134N jėga (Δ134 > 3 mm).

Rezultatai: iš viso vertinti 207 pacientai, 53 (25,6%) vyrai ir 154 (74,4%) moterys, vidutinis amžius 33,21 ± 9,78 metų (nuo 18 iki 55 metų), mediana 33 metai. Vidutinis laikotarpis nuo traumos iki operacijos buvo 17,66 (35,66) mėnesių, mediana 4,5 mėnesiai. Stebėtas statistiškai reikšmingas menisko plyšimų pasireiškimo skirtumas tarp pacientų, operuotų ankstyvuoju laikotarpiu (13 (18,3%)) ir tarp tų, kuriems PKRR atlikta po 12 mėnesių nuo traumos (25 (46,3%)), ($p < 0,001$). Vidinio menisko plyšimo rizikos faktorių analizė parodė, kad KMI (antsvoris) (OR=2,04; 95% CI=1,091-3,814) ir laikas nuo traumos iki operacijos (savaitės) (OR=1,026; 95% CI=1,012-1,04) statistiškai reikšmingai didino vidinio menisko plyšimo galimybę. Mūsų tyrimas neatskleidė statistiškai reikšmingo PKR tamprumo skirtumo tarp matavimų 3, 6 ir 12 mėnesių po operacijos trijose laikotarpių grupėse.

Išvada: tyrimas atskleidė, kad meniskų plyšimo atvejų statistiškai reikšmingai daugiau pasireiškė tarp pacientų, kuriems PKRR atlikta ankstyvuoju periodu ir tarp tų, kuriems rekonstrukcija atlikta po 12 ir daugiau mėnesių po traumos. Kiekviena uždelsta savaitė 1,026 karto, o antsvoris (KMI ≥ 25 kg/m^2) 2,04 karto didino galimybę patirti vidinio menisko plyšimą pacientams, ilgėjant laikotarpiui nuo priekinio kryžminio raiščio traumos iki operacijos pacientams, patyrusiems priekinio kryžminio raiščio plyšimą.

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